CITY OF TEMPE FLOOD IRRIGATION PROGRAM EVALUATION

August 2006

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1.0 INTRODUCTION

1.1 BACKGROUND

The City of Tempe has been operating an irrigation program since the 1920s and has provided irrigation and maintenance services to a portion of the City's flood irrigated residence and business properties. The City provides irrigation service to approximately 900 customers in the relatively older, northern portion of Tempe (see Figure 1 at the end the report). The City does not *own* the system, but has been the *irrigator* for the recipients of the water. In essence, the landowners have unofficially retained the City to operate their delivery system for them.

The irrigation system is operated at low-pressure and consists of various networks of pipelines, concrete manholes, concrete diversion boxes with gated turnouts and customer service lines with on-lot valves. It is estimated that the system has been in operation at least 50 to 60 years without major rehabilitation or modification.

The irrigation system is operated ten months of the year, with two months of dry-up occurring in the fall/winter each year. This dry-up phase coincides with Salt River Project's (SRP's) annual operations and maintenance period. The dry-up phase is designated by SRP and is usually scheduled between summer and winter agricultural growing seasons. The dry-up period is used for maintenance, rehabilitation, and replacement of irrigation system features.

The Tempe Irrigation System Service Area has reduced slightly over the years as landscaping is converted to non-flood irrigated methods and as residential areas are converted to commercial areas. The City has a policy requiring conversion from flood irrigation to non-flood irrigation for lots that convert from residential to commercial zoning. The water rights associated with these properties are cut over to the City and the City provides potable water to the lot. In addition, the number of customers varies as property owners choose to self-irrigate.

The City provides water, sewer and flood irrigation services through the Water/Wastewater Enterprise Fund. There are approximately 41,000 water and sewer customers and approximately 900 irrigation customers. User fees support each of these programs. Funds collected from user fees for each program are to be used to maintain and operate that utility and cannot be used for the other utilities or for other City-provided systems or amenities. The flood irrigation services are not self-supporting and are subsidized by the water and wastewater user fees. The Water Utilities Department has been directed to move these programs to cost recovery. Alternatives for achieving cost recovery for the flood irrigation program include irrigation rate changes, general fund subsidies and other program changes. This report identifies and compares these options.

In addition, there are liability issues for the City that stem from the lack of easements for the irrigation system and formal authorization for the City to provide the irrigation service. The lack of written authorization for access to operate or maintain the irrigation system limits the City's

ability to provide the irrigation service or to maintain the system on private property. In addition, some property owners have chosen to operate their irrigation themselves and occasionally cause damage to the system complicating the issue of liability for system failures and subsequent flooding.

The City implemented a city ordinance to address some of these issues. However, the minimum standards listed in the City Code (Chapter 33 Water, Article III, Sections 33-71 through 33-90) for maintaining private irrigation structures (turnout gates, berms, and lot leveling) are limited in nature. This limitation exposes the City to potential litigation resulting from irrigation water flooding properties and City facilities caused by inadequate private facilities. This ordinance addresses non-payment by the property owner and provides limited requirements for on-lot maintenance and wasteful use of the irrigation water. The provisions under this ordinance are difficult to enforce under the current authorization processes in place between the property owner and the City. Provisions under this ordinance could be strengthened to provide additional requirements and enforcement guidelines that may be needed by the City to continue to provide the irrigation program. This will be addressed further as options for the program are discussed.

1.2 PREVIOUS WORK AND STUDY

In 1993, the City of Tempe contracted with Stantec Consulting, Inc. (formerly known as SFC Engineering Co.) to perform an irrigation system evaluation. The report provided a field inventory of the system, assessment criteria, an evaluation of the physical components, typical components in need of repair or replacement, and preliminary cost estimates for the immediate and long-term rehabilitation of the system. The study was limited to inspections that could be made from the manholes. The report recommended closed-circuit television (CCTV) inspection of the pipelines to better ascertain their condition. At the same time, the lines would be cleaned and flushed; a procedure that had not been completed in the known history of the system.

In November 1998, the City of Tempe let a contract for CCTV inspection for approximately half of the Tempe irrigation system. The CCTV inspection conducted in 1998 and 1999 produced videotapes and written reports for each of the reaches investigated. The inspection procedures included flushing the lines and removing debris. Part of the contract was to add manholes to improve accessibility to the system. Temporary access holes were used where debris (typically concrete grout) prevented the camera from continuing its inspection.

In May 2000, the City of Tempe again contracted Stantec Consulting, Inc. to evaluate the data collected from the first round of CCTV inspection and to prepare the contract documents for the second phase of inspection. Stantec was required to organize the written inspection reports into an orderly format and compile the status information for each of the reaches. Stantec also met with Tempe operation personnel to evaluate the reaches per quarter section and determine the problem areas collected from anecdotal sources. Stantec provided an evaluation of the pipeline system conditions and estimated costs to repair, replace or rehabilitate the pipeline system using the data from the written reports, anecdotal information, field inspections of aboveground conditions and the previous work.

The CCTV Phase II Inspection for the remaining portion of the system was put on hold pending decisions by the City as to how to proceed with the administration of the Irrigation Program. The City was concerned that the revenue generated from the service rates charged to the property owners did not cover the cost of operating, maintaining and rehabilitating the system.

The City is now ready to investigate other options for the administration of the system and this report has been prepared to document these options and provide a basis for recommendations to be made by City Staff.

1.3 SCOPE OF WORK

The goal of this study is to evaluate the options for the City's flood irrigated property owners that currently receive operation and maintenance service from the City of Tempe Irrigation Program. Four administrative options for future operation have been suggested: Properly authorized and funded city-run administration, irrigation water delivery district formation, return to self-serve (water users or irrigation association), abandonment of the flood irrigation system and conversion to potable water system. Specific tasks and functions of the scope of work are listed below:

Data Gathering

- Review 1997 and 2001 Prior Studies
- Collect O&M costs from City of Tempe
- Collect CIP costs suggested by City of Tempe
- Collect potable water supply rate information
- Collect customer mapping and information for both potable and irrigation recipients
- Consult with City Legal staff regarding irrigation water delivery district formation procedures and City-run formation procedures

Cost Analysis

- Update capital improvement recommendations presented in 1997 and 2001 studies to 2005 dollars
- Prepare 5 to 10-year funding estimates for restoration/rehabilitation of the infrastructure
- Prepare operation and maintenance budget estimate based on the existing budgets and recommendations from the 1997 and 2001 studies
- Prepare estimated cost of program if city-run, irrigation water delivery district, self-serve, and conversion to potable water supply

- Prepare Revenue Requirement Study for various program options that can be used in a rate comparison analysis for the four options
- Provide analysis of the estimated cost for each option for typical irrigation customers

Evaluation Report

- Prepare draft evaluation report for staff review
- Finalize evaluation report

Attend Report Presentation to Council:

- Accompany Water Utilities Department Staff to meet with City Council members
- Prepare presentation information for Council Meeting

Public Meetings

- Conduct two public meetings
- Document questions and answers and summarize comments received from public meetings to use in appendix in report
- Attend up to two Council Meetings

2.0 PHYSICAL SYSTEM DESCRIPTION AND ASSESSMENT

2.1 Existing City of Tempe Irrigation Service Area

The existing Tempe irrigation distribution system is found within 13 separate quarter sections in Sections 11, 15, 16, 21, 22, 23, and 27 of Township 1 South, Range 4 East of the City of Tempe (see Figure 1). The existing irrigation service area is roughly bounded on the north by McKellips Road, on the south by Alameda Drive, on the east by McClintock Drive, and on the west by Hardy Drive. The total service area of business and residential lots is approximately 630 acres. It is estimated that there are approximately 1,800 residential and commercial lots that could potentially be irrigated from the existing system. However, only about 900 are currently receiving service from the City. The number of irrigation customers has reduced over time. Some of the lots have cut over their water delivery to the City when the property converted from residential to commercial and now receive potable water rather than raw water from SRP. Some of the lots have always been self-serve lots and some have converted to self-serve either due to rate increases or the desire to self-irrigate. The largest single-owner parcels served by the system are Arizona State University, schools and City's parks within the service area.

2.2 Physical System Description

The system is a low-pressure irrigation delivery and transmission system. The system consists of various networks of pipeline, concrete manhole diversion boxes with gated turnouts, and customer service lines with valves. It is estimated that the system has been in operation since the 1920s and 30s.

The 1993 study completed by Stantec Consulting evaluated the system as a whole and provided recommendations based on the information that was available from aboveground inspections. The 2000 report focused on the pipeline system condition itself and prepared an overall assessment of the system to determine a proposed cost to repair/replace the system. The following summarizes the condition of the system and its functionality based on these prior studies. A proposed capital improvement program is also provided for use as a basis for rate studies.

2.2.1 System Capacity and Operations

The 1993 study ascertained that the delivery system could meet the consumptive use demands without having to extend the irrigation cycle. The theoretical peak 14-day irrigation requirement was determined to be 314 miner's inches (7.85 cfs) and the actual flow rate is approximately 300 miner's inches (7.5 cfs). Matching the consumptive use requirement to the actual flow demand indicates two things: (1) the system is adequately sized as constructed and (2) the system is not experiencing major leakage problems. Operations personnel identified that the system is still able to provide adequate irrigation over the system. However, individual areas cannot be over-pressurized without the potential to cause a pipeline leakage and a break.

2.2.2 Manhole Structures Assessment

The previous studies ascertained that even though the 30- to 50-year life typical of these structures had been met or exceeded, they still appeared to be in adequate condition to last another 20 years. The 1993 study recommended programming a 5% replacement over a 20-year period and that is reasonable for a capital program projection.

A number of pressure manholes were constructed and buried during the 1998/1999 video inspections. These manholes were added to provide access to grout blockage locations. The pipe was opened to remove the grout and allow video inspection to pass through the pipeline. This is discussed in greater detail in Section 2.2.5.

2.2.3 Manhole Structure Covers Assessment

The City has replaced all wooden covers with locking metal covers and replaces these covers if they become damaged. The cost of replacement is a nominal item for the capital improvement program.

2.2.4 Gates Assessment

It was estimated in the 1993 inventory that there are approximately 300 gates within the Tempe irrigation distribution system. Approximately 40 to 50 percent are cast iron gates and the remaining are galvanized slides or galvanized jack gates. In general, all gates, stems, and lifting mechanisms were properly lubricated and worked easily.

The life of the cast iron gates was estimated at 20 to 40 years old in the 1993 study. The gates appeared to be functioning adequately and should only require replacement if leakage is causing a problem when closed. It was recommended that bent stems be replaced and that stem nuts be installed to prevent over-closing the gates and further bending the stems. A stockpile of cast iron gates for replacement was not recommended because the gates are slow to rust out and are expensive. Replacement gates can be ordered within a week, if needed. The 1993 study recommended programming the cost of one cast iron gate over a 20-year period.

The galvanized slides or jack gates appeared to be in fairly good condition. These gates are an inexpensive variety that will rust through as they age, but are suitable for irrigation systems. A small stockpile of galvanized slides and gates should be kept on hand to replace rusted gates as needed. The 1993 study recommended programming the cost of six galvanized slide or jack gates over a 20-year period.

The City recently replaced approximately 15 slides and gates (6 of which were cast iron gates); a much greater rate of replacement than expected in the 1993 study. The largest problem now appears to be either vandalism or improper operation by the self-irrigating property owners. If stem nuts have not been installed to prevent overclosure, operational staff might consider adding these nuts.

In future, slides and gates may be replaced at a greater rate than the 1993 study suggested; however, replacement of these gates and slides is considered a nominal portion of the annual maintenance required.

2.2.5 Pipeline Drainage System Assessment

The Tempe irrigation distribution system has no drainage outlet for many pipeline reaches within the system and no access at the ends of these reaches to flush the reaches and remove sand, silt, debris and other garbage. There are approximately 170 reaches within the system and approximately half are terminal reaches and approximately two-thirds of these reaches do not have manholes at the ends of the reaches. However, maintenance personnel identified that sediment and debris accumulation is not a severe problem. It was mentioned by maintenance crews that a high-pressure sprayer is used once or twice a year to remove sediment and debris plugs from those reaches that become a problem.

Recommendations in the 1993 study were made to make sure that the manhole covers fit tightly to prevent passers-by from using the manholes as garbage cans. In addition, it is recommended that manholes be added to reduce long reaches and allow for the opportunity to flush the pipelines, if necessary. The 1993 study also recommended installing manholes at the terminal ends of pipelines to improve maintenance procedures.

As a result of the 1993 recommendations, the original scope for the 1998/1999 CCTV inspection of the northern portion of the system called for manholes to be added to reduce long reaches and at the terminal ends of many lines in the Phase I area. Many additional manholes were constructed to provide access to pipelines at the numerous blockages found in the inspection. The number of manholes called for in the Phase II CCTV inspection was increased based on the pipeline blockage problem found in Phase I. However, the second phase of video inspection was not completed.

It is recommended that the Capital Improvement Program in this report include installation of approximately 10 manholes per year for the next five years; some of these could be temporary access locations only to remove grout.

2.2.6 Pipeline System Assessment

There are approximately 23 miles of pipeline ranging in size from 8 inches to 36 inches in diameter (see Table 2.1 at end of Chapter). The majority of the existing pipeline is nonreinforced concrete pipe with joint lengths varying between 3 feet and 6 feet. The vast majority of the pipeline is 18-inch (approximately 41%), 16-inch (approximately 12%) and 14-inch diameter pipe (approximately 18%). Estimated value of the system is $17 million and is based on $8 per diameter inch per linear foot of pipe for new installation in relatively unrestricted construction.

In 1998, Tempe provided quarter section maps for approximately half of the system to Southwest Hoffman for use in the CCTV inspection. The following table identifies which sections of the system were studied in each phase. The first CCTV inspection and the 2000

Stantec evaluation report only covered the Phase I reaches in detail. Projections for capital improvement for the second phase were made based on the conclusions of the first phase.

Phase I	Phase II
NW ¼ of Sec 11	SW ¼ of Sec 22
SW ¼ of Sec 15	SE ¼ of Sec 22
SE ¼ of Sec 15	NE ¼ of Sec 23
SE ¼ of Sec 16	SE ¼ of Sec 23
SW ¼ of Sec 16	NW ¼ of Sec 27
SE ¼ of Sec 21	NE ¼ of Sec 27
NE ¼ of Sec 21	
NW ¼ of Sec 22	

In the 2000 review of the system, it was determined that the system was in fair to good condition and it was recommended that the City should continue to operate the system as is and make repairs as needed. Wholesale replacement of the system was not considered practical and would be extremely costly. Part of the recommendation was based on problems associated with lack of right-of-way for the system, significant vegetation and landscaping over the pipelines, pipeline location at back of lots and under buildings and inadequate funding for the program through the irrigation user fees. It was noted at the time that the irrigation user fees did not even cover the operation costs of the system let alone wholesale replacement of the system and this is still accurate.

Rehabilitation or restoration techniques for aging pipe include parallel line replacement, removal and replacement of pipeline, insitu-lining, pipe bursting, spot fixing from the exterior and spot fixing with steel sleeves. Installation of a parallel line or removal and replacement of the existing lines are extremely costly techniques that require access to the alignment, adequate easement and temporary service outage that may exceed the allowable time frames for irrigating the properties. Insitu-lining is a specific brand name that often gets used for the generic technique of slip lining an existing pipe. Insitu-lining is typically performed by installing a flexible liner available in various media that is expanded and in some cases hardened inside the existing pipeline. Some insitu-lining techniques increase or restore the pipe structural integrity and some are merely liners that seal the pipe to prevent leaking. Pipe bursting is a technique that is used to pull a new pipe inside an existing pipe. The new pipe outside diameter may match the inside diameter of the existing pipe or the new pipe may be up to several inches larger in diameter. By pulling the liner pipe through the existing pipe, the existing pipe is burst. The ability to increase pipe diameter is based on the type of existing pipe and the soil conditions surrounding the pipe. Exterior spot fixing requires opening the pipe from above and patching the pipe from the exterior through a variety of patch and concrete wrap techniques. Interior spot fixing using steel sleeves is a newer spot fix that entails the placement of 3-foot, epoxy-coated,

stainless steel sleeves at repair locations. Multiple sleeves can be installed to allow cost-effective lining up to about 20 feet.

The irrigation system is reaching the normal book life for concrete pipe and that causes some concern about how long before serious failures might occur. There are some areas where the pipe is showing signs of age. The inverts are worn and in some locations there is extensive root intrusion (see photographs at end of Chapter). In addition, the inspection reports for these pipelines indicate that there are a number of large patches that have been made to these lines, which may indicate potential problems with the pipe. Detailed repair recommendations for specific reaches were provided in 2000 for each quarter section evaluated.

Current assessment by City staff identified that if the system is over-pressurized, leakage occurs and it is likely that a pipeline failure will ensue. Two reaches totaling 900 linear feet, which were identified in the 2000 study as high priority reaches, were insitu-lined in 2005-06 at a cost of approximately $200,000. This is indicative of the periodic insitu-lining or major repair that will be required to maintain the system as it continues to age. It is anticipated that insitu-lining will extend the pipeline life for up to another 50 years and is the most cost effective restoration method for lines that cannot be relocated or replaced. However, each reach should be evaluated to determine whether replacement or insitu-lining is the least cost option.

Numerous repairs or patches have been made to the pipelines. Most of these patches were made by placing concrete chunks into the holes and grouting around the “patch” to prevent leakage. It is difficult to determine from internal inspection whether all of the broken/patched areas are fully repaired and no longer leak. It was assumed, based on conversations with Tempe staff, that most of these patches do prevent leakage. Broken pipe areas that looked wet, had root intrusion or where external soil could be seen were recommended for repair. All others were noted as patches only in the video inspection and 2000 study.

Grout was used to fill abandoned service lines. Sometimes this grout slipped into the pipeline or an excessive amount of grout was used. In addition, it would appear that joint grouting in the original construction might also have been quite sloppy. Heavy grout prevented video inspection in many locations and was a primary cause for uninspected Tempe lines. Grout in a low-pressure line is not a major operational problem unless it blocks a significant portion of the pipeline. However, it is a problem for video inspection, which is used to identify potential failure and pipeline problems. Rarely were pictures taken of the grout making it difficult to determine the extent of the problem. Grout problems were noted and locations given, but only the locations where blockage is more than 25% of the pipeline open area were included in the repair work cost estimate in the 2000 study.

In the 2000 study of this system, and irrigation system studies in general, it was thought that root intrusion was not a significant problem if it was minimal and not causing a blockage. However, after 10 to 15 years of video inspection of irrigation pipeline systems, it has been found that root intrusion increases with time and can significantly damage the pipe by increasing the crack or joint separation. In addition, water can be leaking out of the pipelines through cracks, holes or joint displacements and this worsens over time as the roots grow and enlarge the penetration locations. Holes, cracks and joint separations should be repaired to prevent

further damage to the pipe and root intrusion. At a minimum, roots should be clipped during CCTV inspection and if possible the source should be removed for root intrusion at cracks and displaced joints. Grouting cracks and pipe displacement is often not effective to prevent root intrusion because of normal pipe flexure and the grout falls out. Epoxy coatings or patches are not effective because it is difficult to clean the pipes well enough for good adherence. Insitu-lining and spot fixes using stainless steel liners or exterior patching are solutions for extensive root intrusion.

Hairline radial and longitudinal cracking was not originally considered a significant problem and would still not be a problem unless the cracking is extensive or there is some evidence of leakage, either through root intrusion or discoloration around the crack. Grouting hairline cracks is not an effective repair technique because the grout cannot usually be pressurized into the crack far enough to be effective. In addition, the grout falls out as the pipe flexes with water pressure and ground movement. The best fixes are insitu-lining (when the problem is extensive) and interior stainless steel pipe sleeves (when the problem is less extensive or localized). In the case of the City system, exterior grouting or diaper wraps or short reach replacement may be a solution because the pipes are relatively small and shallow. Each location will have to be evaluated based on accessibility and severity of the problem.

Worn inverts were a problem in places. The only solution for worn inverts is insitu-lining, stainless steel liners or pipeline replacement. The suggested solution will depend on the length of the problem and accessibility of the pipeline. It is unlikely that replacement will be preferred over insitu-lining due to cost and accessibility. Stainless steel liners can be effective for problem reaches of 20 feet or less.

In general, it is recommended that the City continue to monitor the pipeline system, provide spot repairs using small pipeline replacements or stainless steel pipe liners for damaged locations less than 20 feet in length and insitu-line longer reaches that have been identified with worn inverts, extensive cracking or extensive leakage. Wholesale replacement of the pipeline system is not recommended due to the cost and the limited return on investment at this time. As problems are identified, they should be evaluated against the long-term benefit of replacement versus spot fixing.

An ancillary problem that compounds the selection of maintenance, repair and replacement techniques is the lack of written right of access to properties where the irrigation system is located. Aboveground replacement techniques are hampered because the City does not have full access to the entire system. In addition, the City is unable to restrict certain types of landscape and vegetation near or on the pipelines themselves. For example, root intrusion cannot be controlled by enforcing a “no-tree or no-oleander” prohibition on or near the pipeline policy. These issues will be evaluated in greater detail in Chapter 4.

2.2.7 Private Irrigation Structures

Private irrigation structures were one aspect of the physical system that was not evaluated in previous studies. Private irrigation structures are located at each residence or commercial lot and are maintained by the landowner. The structures include alfalfa valves and other on-lot

turnouts, berms, culverts under sidewalks and between various portions of the lot and topography of the lot itself. Part of the success of flood irrigation is the ability for water to flow from the turnout to the farthest corners of the plot easily and smoothly. Water should buildup to an even depth, then be shut off and the depth of water allowed to infiltrate. The lots should be sloped and maintained to allow water to flow evenly over the lot without overflowing the outer boundary berms before reaching the end of the lot. Flooding may occur if water cannot flow easily over the lot because of heavy, unmaintained vegetation, inverse slopes, high spots, plugged culverts under sidewalks, uneven berm heights around the outer boundary of the lot or unmaintained berms that breakout during irrigation.

The City has implemented limited on-lot requirements under City Code, but the Code is not adequately detailed and is difficult to enforce (Chapter 33 Water, Article III, Sections 33-71 through 33-90).

2.2.8 Proposed Capital Improvement Program

Previous Stantec studies compared the cost of complete replacement of the system to partial replacement over time to specific repairs/replacements on an as-needed basis. Based on the high cost of replacement and limited available funding, previous CIP recommendations have taken a minimalist approach. The problem with this approach is that if there is a failure, it can be extremely expensive and will probably occur during the peak irrigation season. The resulting costs for repair or replacement are often quite high.

A capital improvement program (CIP) suggested at this time should assume that the system would remain in operation indefinitely. Therefore, elements of the program have been included to attempt to forecast proactive maintenance, repairs and replacement as needed or just before it is needed. The elements included in the CIP include a monitoring program, a maintenance program, a replacement program for manholes and gates, a repair program for cracked pipe or minor failure locations and a major repair (insitu-lining typically) program. Costs are presented for each element for a projected 10-year period on Table 2.2 (at end of Chapter). The 1998/99 video inspections and the detailed pipeline analysis in 2000 have been used to project expected problems and expected cost to repair/replace and maintain the pipeline system.

The first step in a good proactive system is monitoring the infrastructure to try to predict future problem areas and then correct them prior to failure. With a pipeline system, the best, least-cost monitoring technique is interior video inspection. Table 2.2 provides a recommended cost for routine pipe cleaning and root removal. The City can either implement through use of a local video and pipe cleaning services or through self-performance this program. Pricing included on Table 2.2 reflects the expected market rate for pipe cleaning and video inspection.

A good video inspection program of an irrigation system requires extensive cleaning and root removal in irrigation lines to allow proper inspection of the pipe interior conditions. The cost of the cleaning and root removal typically greatly exceeds the cost of video inspection. Anticipated costs for video inspection, cleaning and root removal would be around $3.125 per linear foot or $16,500 per mile. Root removal is an on-going maintenance issue and is not eliminated by clipping the roots periodically. Therefore, it is anticipated that this program will continue for the

life of the pipeline. Insitu-lining and steel sleeves are the best permanent fixes for root intrusion locations, but these are expensive.

Based on the 1998/99 video inspections, it is feasible for the entire system to be evaluated every four years. However, a slower schedule would allow crews to complete minor repairs at the same time within the dry-up or reduced winter flow months. The proposed schedule presented on Table 2.2 recommends inspecting approximately 10% (2.5 miles) per year. During this inspection, it is recommended that the pipelines be thoroughly cleaned and the roots removed. In addition, cracked pipe or minor damage locations should be noted for exterior or interior spot fixing. Spot fixes can be completed by either short-pipeline replacements, exposure of the pipe and concrete wraps or steel sleeve installations. If steel sleeve installation is the preferred repair technique, then pipe diameter should be measured during the video inspection and stainless steel liners ordered.

It is anticipated that the pipe diameters will not be consistent based on the age of the pipe and inaccurate knowledge of the pipe materials. Stainless steel liners will need relatively accurate interior diameter sizing in order to be effective. The location for the sleeve should be noted in the video inspection and when the sleeves are delivered, the sleeve can be installed in that year or a following year.

Based on the information collected in the 1998/99 video inspections it is estimated that there will be approximately 15 small repairs per mile required for the system. The Table 2.2 line item to repair cracked or minor damage locations assumes 15 small repairs per mile at approximately $5,000 per repair location. This includes the cost of the liners and time to install.

It was suggested in the 1993 inventory that the manholes and diversion boxes were in relatively good condition; therefore, a replacement of 5% over 20 years was suggested. In addition, it was recommended that manholes be added to terminal locations to allow access at the downstream end of the pipelines to remove debris during cleaning operations. The 1998/99 video inspection scope of work called for the replacement of nine manholes at terminal locations. However, the actual number of manholes was significantly greater than expected because manholes or temporary access into the pipe was required at various midpoints to remove grout or to allow the camera to pass grout blockages. It is assumed that additional manholes will be required both in the northern system for locations where CCTV inspection could not be completed and for the southern portion of the system that has not been video inspected. Table 2.2 includes the cost to construct manholes on an annual basis as part of the video inspection. Estimated cost for new manholes is listed at $7,500 each. Estimated cost to remove and replace manholes is listed at $15,000 each to cover the higher cost of removing manholes and replacing them in the same location.

In the 2000 evaluation, it was determined that there was only one location requiring extensive repair or replacement. Approximately 200 linear feet of 30-inch pipeline was recommended for replacement and another 700 feet was identified with numerous spot fixes. Both of these reaches were insitu-lined in 2005. Numerous other locations were recommended for spot fixes rather than full-scale replacement. Spot fixes entailed opening a location, cutting out a section of pipe and replacing it. Spot fixes were usually recommended for sections less than 20 feet.

Replacement of longer reaches was usually recommended over insitu-lining because of the high cost of insitu-lining at the time. Only reaches that were inaccessible from above were recommended for insitu-lining.

In the current market insitu-lining is now less expensive than replacement for these irrigation systems. It is recommended that most major repairs should be completed with insitu-lining rather than replacement.

Another technique that has not been used much in the valley is pipe bursting. This pipe replacement method pipe is constructed by bursting the existing pipe from within while simultaneously pulling in a new pipe. The new (liner) pipe can be the same diameter or as much as two sizes (4-inches) larger than the existing pipe depending mainly on the soil conditions. One possibility is to install slightly smaller interior pipe like a sleeve and not burst the existing pipe except in areas where the diameter varies slightly from irregularities. The new pipe diameter will be slightly smaller, but the new pipe is a very smooth pipe and may have adequate flow capacity even with the smaller diameter. It is feasible that this technique may be suitable for the City of Tempe system and a demonstration project might be in order to determine its feasibility/efficiency.

Opening small reaches and replacing sections of pipe can still effectively repair spot locations. However, a second technique has become available that would allow the repair from the inside for reaches that are inaccessible from above. Stainless steel liners are inserted into the existing pipe at the crack or break and expanded. The liners are coated with a grout or epoxy compound that fills the holes and cracks in the existing concrete pipe. The stainless steel liner ensures that the grout/epoxy remains in-place. Other interior spot fix products are coming onto the market at a regular pace now because of the concern in other parts of the country for aging pipe utilities. The City should consider the new techniques as they become cost-effective and are found to be suitable.

Table 2.2 lists two types of repairs: minor and major repairs. It is estimated that there will be a few minor locations that will require repair each year as the pipe is inspected. It is also expected that there will be locations that will require more extensive repair. Annual costs have been listed for the minor costs based on an estimated number of cracks per mile of pipe. It is also estimated that approximately one percent of the system will require insitu-lining or major repair every five years. Spot repairs are estimated at $5,000 per repair and this price is expected to cover either an exterior or interior repair. Insitu-lining is estimated at $5 per diameter inch and it is estimated that the average pipe size is 18-inches in diameter.

2.3 Existing Operation and Maintenance of the System

There are seven irrigation department employees and one temporary employee who irrigate and maintain the distribution system with one supervisory person assigned to manage the program. These personnel are funded 75% through the irrigation program and 25% through the water/wastewater program for non-irrigation functions. The irrigation system is operated and maintained 12 months of the year with irrigation deliveries in ten months of the year and major maintenance in two months of dry-up occurring in the fall. This dry-up phase coincides with Salt

River Project's (SRP's) annual operations and maintenance period. The dry-up phase is designated by SRP and is usually scheduled between summer and winter agricultural growing seasons. SRP and irrigation districts use the dry-up period for maintenance, rehabilitation, and replacement of irrigation system failures.

2.3.1 Irrigation Deliveries

City irrigators work shifts covering the entire 24-hour day during the irrigation season. Irrigation deliveries are made to approximately 900 lots over a 2-week irrigation cycle. During fall and winter months when irrigations are reduced to one per month, employees maintain and repair the irrigation system.

Primary deliveries for the Tempe irrigation distribution system Service Area are divided between the North and South. Apache Boulevard east of Mill Avenue and 13th Street west of Mill Avenue generally divide North and South Tempe irrigation areas. Each area receives approximately 150 miner's inches (approximately 1,680 gallons per minute) throughout the 10-day period.

The majority of homes in the service area receive irrigations from Tempe irrigation personnel; however, there are some customers on the system who deliver their own irrigation water. Irrigation water is delivered to a lot until water levels are near the top of the lot's irrigation berms. No more than two or three lots are irrigated at any one time to reduce the potential for damaging the old pipe from excess pressure and to reduce the chance of overtopping an irrigation berm.

The largest single-owner parcels to receive service from City irrigators are ASU, some schools and some City parks. Tempe irrigation personnel deliver to a single turnout for ASU and then ASU personnel handle the on-Campus distribution of water. The ASU irrigation distribution system is not independent of the City-operated system. The distribution system that passes through ASU continues back to other City-operated properties.

2.3.2 Other Maintenance and Operation Functions

The City irrigation personnel are also responsible for the maintenance of the system. Repairs and routine maintenance are made on the existing system during the year on an as-needed basis. However, the major repair and cleaning of the system is conducted during the SRP dry-up. Responsibilities of the employees during this period include cleaning out debris from manholes and pipeline, flushing out sediment from plugged lines, repairing breaks in pipelines, repairing or replacing gates in manholes, and repairing or replacing manhole covers/grates.

The City has operated a reactive program for the system rather than a proactive program for several reasons. The system is not located in a defined, written right of access, which means that the City must have permission to enter a lot. It also means there are no restrictions in place to prevent landowners from constructing over the top of the system or otherwise damage the system. The City has not established minimum criteria for landscape on or near the pipeline or for the on-lot irrigation features.

In addition, the current rate schedule for the irrigation system is too low to cover the annual operation and maintenance costs without adding a major repair/replacement program or even a proactive prevention program to extend the life of the system. This restriction in funds and lack of a proactive maintenance/repair/replacement program could lead to a catastrophic failure of the system in the future.

A long-term proactive maintenance program should include periodic interior inspection of the system with extensive cleaning and root removal. Root intrusion is a problem in pipeline systems in urban areas.

2.3.3 Operation and Maintenance Costs

Operation costs were collected from the City of Tempe and have been presented in Chapter 5. Minor capital expenditures such as gate replacements, lubricants, etc. have been included with the major maintenance expenditures and are included in the CIP recommendations presented in Section 2.2 and Table 2.2.

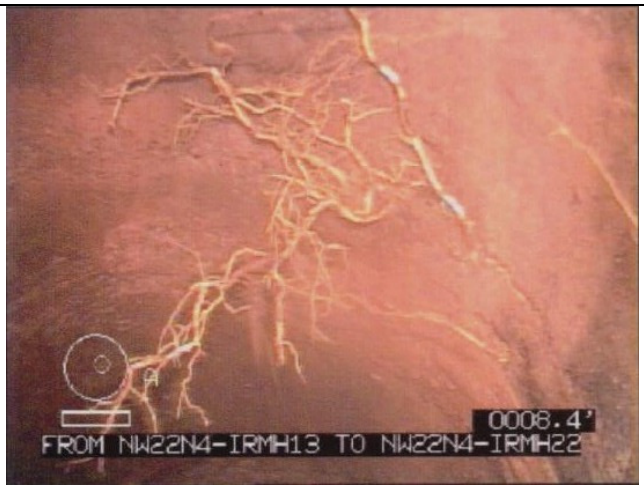
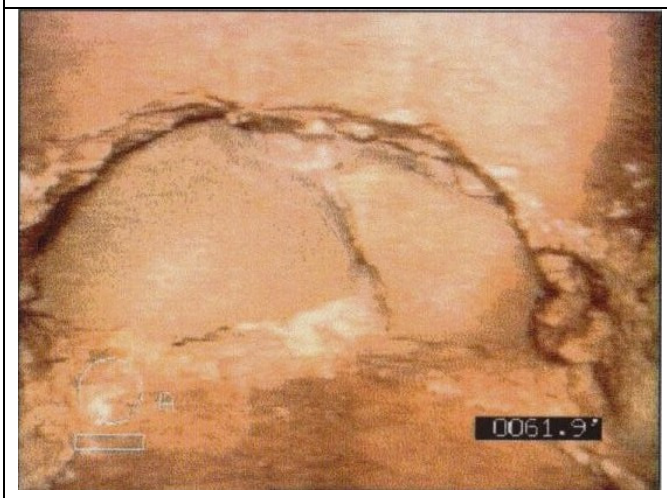
Table 2.1
Total Length of Laterals by Quarter Section
City of Tempe Irrigation Program Analysis--2006

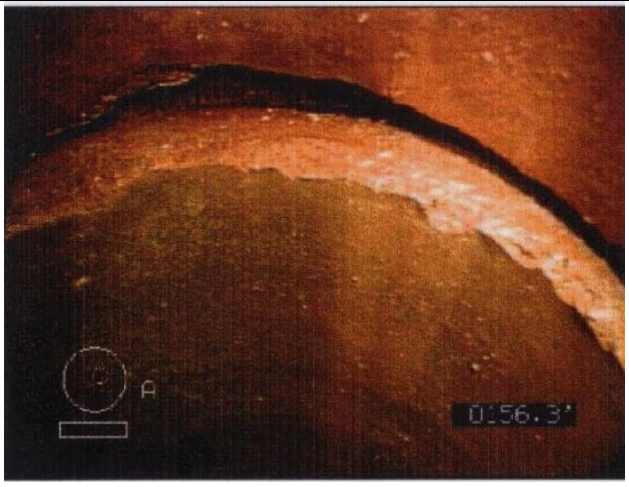
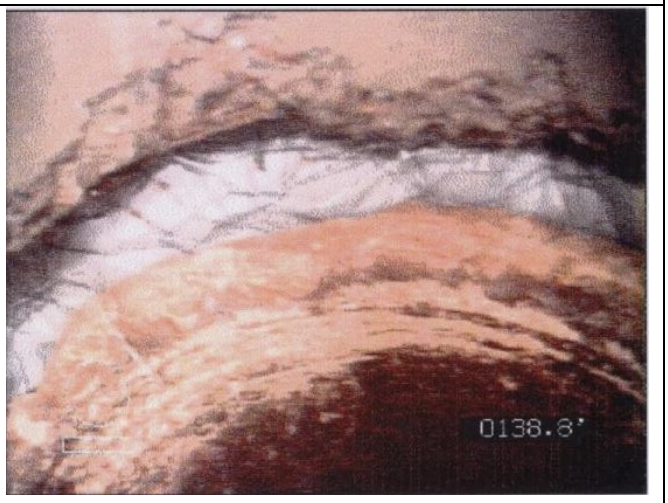
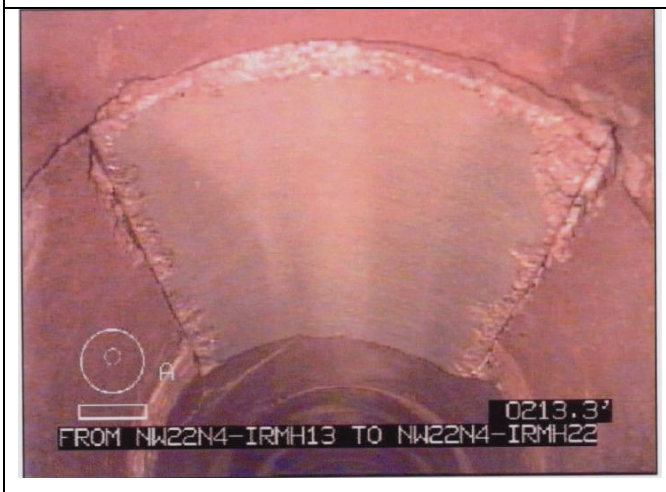
Section	Pipe Lenth (feet)											
	36 inch	30 inch	26 Inch	24 inch	24 inch tube	20 inch	18 inch	16 inch	14 inch	12 inch	10 inch	8 incl
Northern Half of Irrigation System												
NW11N4								3,114		2,475		
SW15N4				1,516			2,605			953		
SE15N4		1,830								2,350		
SW16N4						285		945	1,780	1,262	874	
SW16N4												
SE21N4							1,610			7,272	1,694	
NE21N4		200		218	492	660	2,696	1,598	469	16,037		
NW22N4	350	3,080		360	231		1,025		1,440	4,584	750	3,785
Subtotals	350	5,110	0	2,094	723	945	7,936	5,657	3,689	34,933	3,318	3,785
Southern Half of Irrigation System												
SW22N4				553			6,214			8,432		
SE22N4						785	8,677			976		
NE23N4			328				5,533			1,390	640	
SE23N4	20			484			5,594	870	5,067			
NW27N4						316	465	2,460	1,833	26	1,397	
NE27N4				2,589			1,118	3,662	3,935			
Subtotals	20	0	328	3,626	0	1,101	27,601	6,992	10,835	10,824	2,037	0
Totals	370	5,110	328	5,720	723	2,046	35,537	12,649	14,524	45,757	5,355	3,785
Unit Cost	$288	$240	$208	$192	$192	$160	$144	$128	$112	$96	$80	$64
Estimated Value of System	$107,000	$1,226,000	$68,000	$1,098,000	$139,000	$327,000	$5,117,000	$1,619,000	$1,627,000	$4,393,000	$428,000	$242,0(

Estimated value based on $8/dia-inch/linear foot for new instalation

Table 2.2
Capital Improvement Program for 10 years
City of Tempe Irrigation Program Analysis--2006

Recommended Program Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Clean and CCTV Problem 10% of System per Year (+/-2.5 mile)	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000
Terminal Manhole Installation ($7,500 each) (10 per year for the first five years as part of the CCTV on the southern half)	$75,000	$75,000	$75,000	$75,000	$75,000					
Manhole Replacements @$15,000 each (2.5% replaced of 200 manholes over 10 years)				$40,000					$40,000	
Repair Crack & Minor Damage Locations Using Localized Repairs/Replacements (estimated 15 cracks or repairs per mile of inspected pipe)		$187,500	$187,500	$187,500	$187,500	$187,500	$187,500	$187,500	$187,500	$187,500
Major Repair Estimates (1% of System evaluated @ $5/dia in/lf for 18" dia) (Major repairs assumed only every 5 years)					$105,970					$105,970
Totals	**$115,000**	**$302,500**	**$302,500**	**$342,500**	**$408,470**	**$227,500**	**$227,500**	**$227,500**	**$267,500**	**$333,470**

	
Typical Pipe Invert Without Cleaning	Minor Root Intrusion
	
More Extensive Root Intrusion	Major Root Intrusion
	
Broken Hole Patch; No Leakage Apparent	Broken Hole Patch; No Leakage Apparent

	
Broken Hole Patch; No Leakage Apparent	Open or Separated Joint
	
Open or Separate Joint	Open or Separated Joint
	
Patched Temporary Access Location	Pipeline Intrusion Into Irrigation Line

3.0 SIMILAR IRRIGATION PROGRAMS EVALUATION

Irrigation water is provided to small residential and commercial lots in other parts of the valley through a variety of "self-serve" programs. In these programs, property owners request water during the regular delivery schedule from SRP and irrigate their property on their own or hire private irrigators to provide the service. There are a few City irrigation programs that order and deliver SRP water to residential areas and parks, but they are much smaller and less comprehensive programs than the COT program. Table 3.1 is a summary of the residential irrigation programs conducted in other Phoenix area cities. All data collected in this section was provided by specific personnel at each of the cities and has been included here with as much accuracy as possible.

3.1 SRP Deliveries to Other Residential/Commercial Users

In self-irrigated areas of the SRP Service Area, SRP deals directly with the individual landowners and they are billed on an annual basis for the delivery of irrigation water. The annual bill from SRP includes a storage and delivery fee. Delivery is made at the SRP irrigation turnout structure. The water can be ordered and distributed directly by a landowner or by an "irrigation company" acting on behalf of the landowner. Water orders can be placed using a sign-up form in the local "water order box", by telephone or by going on line to the SRP web site. SRP deals directly with property owners in the south part of Tempe outside the COT Irrigation Service Area and in other parts of the valley. SRP contacts were unaware of any private irrigation companies operating in the southern part of Tempe.

SRP provides a pamphlet, VCR tape and CD to residential irrigators when requested. The materials provide a brief history of SRP, the SRP watershed, system of dams and canals, and its governing body. In addition, the materials provide instructions on how and when to order irrigation water, SRP's responsibility and the landowner's responsibility for the water delivery, maintenance and repair of the private system components, suspension of service due to disrepair and potential flooding or other damage, and how to resolve disputes between neighbors.

Residential property owners may opt out of irrigation and can opt back in at a later date by making a formal request to SRP. In addition, subsequent owners of previously opted out property can petition SRP for reinstatement to residential irrigation.

SRP customers are charged for the delivery and storage of water. For residential lots, SRP delivers up to 6 ac-ft per acre of water per year. SRP delivery flow rate is 50 miners inches (1.25 cfs) for 45 minutes per typical lot. During normal water supply years, each lot receives up to 18 irrigation runs per year. In 2003 and 2004, the irrigation runs were reduced to 16 due to drought conditions.

Residential lots are rounded up to the nearest 1/5th acre for allocation and billing amounts. The typical water delivery quantity is 1.2 ac-ft per year per 1/5th acre lot. In 2005, the SRP storage and delivery charge for a "typical" 1/5th acre lot was $59.85; for a double (2/5 acre) lot, $95.55; and for a 1 acre lot, $124.40. Irrigation water delivery rates are broken down as follows:

$11.50 per AF for 1 to 3 acre-feet.
$38.50 per AF for pumped water
$43.75 per AF delivery fee.

SRP provides maintenance and repairs only to its system, which usually ends at the turnout to the residential system(s). The properties on the self-irrigated distribution system are responsible for the maintenance and repair of their system. The property owners can hire their own contractor or SRP will give them a free estimate for SRP to do the work. If SRP notices that flooding or other damage is occurring due to system damage, they may suspend water delivery and notify the relevant customers accordingly and provide a description and recommend repair of the system. However, if the customers request water delivery and are willing to accept responsibility for any damage, SRP will resume water delivery.

According to SRP contacts formation of an "irrigation company" by the private residential owners was not a problem for SRP or their legal structure. SRP contacts thought the legal and procedural work required to form a district could be difficult, but if formed, a district operating the residential systems was acceptable. SRP was not aware of any formal irrigation districts that had been formed.

3.2 Private Irrigation Companies

A list of contractors that provide commercial irrigation services was provided by SRP. Some provide service to both individual residences and subdivisions and some only service subdivisions. Some of the companies provide valley service and others work in a regional area. Most of the irrigators provide similar services that include ordering water and opening and closing gates to control the water flow. Billings for services are usually made quarterly. Charges by private water delivery companies are in addition to the cost of water delivery by SRP to the customers.

Salt River Irrigation (SRI) was contacted and provided the following information. SRI is currently under contract with the City of Glendale to provide irrigation service to the city's approximate 410 irrigation customers. They have been under contract to Glendale since 1989. In addition to Glendale, SRI provides irrigation service to about 1,400 private residences, 105 schools in six school districts. SRI monitors the condition of the Glendale system and has a working arrangement with Premier Construction for minor repairs of the system. SRI provides irrigation water delivery services only for about $15 per irrigation. The cost of the SRP water delivery is billed separately by Glendale to each customer.

SRI irrigation services provided to the non-Glendale residential customers typically only include ordering water from SRP and opening and closing the valves on the private system and on the residential lots. SRI billing for residences averages about $15.00 per irrigation. With 18

irrigations per year, the total cost charged by SRI is about $270 per year. SRP bills the non-Glendale residential customers separately for SRP water delivery.

Maintenance of the non-Glendale system remains the responsibility of the landowners and is a cooperative, voluntary funding arrangement. SRI maintains the Glendale irrigation system as described above through Premier Construction. This maintenance is not a long-term, proactive maintenance that will ensure the long-term functionality of the irrigation distribution system.

3.3 Other Valley City Irrigation Programs

Other cities provide or have provided an irrigation delivery service to property owners in their city similar to the COT program; however, these systems are not nearly as large or as comprehensive as COT's system and service. These cities all deliver water from SRP to the individual private residences and businesses. Charges for these services are in addition to the cost of water delivery by the primary Irrigation District. The following is a brief summary of these other valley city irrigation services.

3.3.1 City of Peoria

The City of Peoria has turned over its irrigation program to a group of existing land owner/irrigators in the downtown area who have formed, under the Arizona Corporation Commission, a "Peoria Water Users Association" to run the system. Peoria is got out of residential irrigation due to the age and condition of the system and the estimated $500,000 needed to make the repairs and replacements to upgrade the system. The City established a $180,000-program under which each irrigation landowner was offered a $3,000 grant to convert to potable irrigation water and install desert landscaping. The City has paid out the entire $180,000 to the irrigation system participants, and although the grant money was offered to help participants convert to potable water irrigation or desert landscaping, the city does not plan to follow up on how exactly the grant money was used.

The Peoria Water Users Association (PWUA) has assumed the operation and maintenance of the irrigation system with the official transfer completed in the April 2006 City Council meeting. The PWUA may be requesting the irrigation participants contribute funds from the city grant to be put towards the system repairs.

The City operated the residential irrigation system from 1954 when the city was incorporated to 2006. From 1948 to 1954, the Peoria Chamber of Commerce operated the irrigation system that delivered water from the SRP primary delivery system to each of the private residential and commercial property owners. The annual irrigation service charge in 2005 was $90.00 per parcel for each of the 50 parcels irrigated for a total revenue stream of $4,550 per annum for the entire system. The annual cost to operate the system was between $40,000 and $50,000. The City heavily subsidized the irrigation program. The City irrigation service charges are in addition to the raw water delivery charges from SRP. The City irrigation service delivered from March through September each year.

3.3.2 City of Mesa

The City of Mesa (Mesa) operates a city run residential irrigation system that delivers irrigation water from the SRP primary delivery service to about 400 residential customers and 8 city parks. The service area covers about 1.5 square miles bounded by Country Club Drive on the west, Mesa Drive on the east, 8th Street on the north and Broadway Road on the south, plus small areas jutting out on the east, south and west.

The city has three full time and one part-time (1/2 time) employees to operate and maintain the system. Billings are based on time required to service each account. Current billing rates are based on time to provide service at $36.58 per hour, which includes 7.5% tax and includes the cost of the water delivery charged by SRP. The program is self-sufficient and no city subsidies are required. The City billing department receives a monthly report from the irrigation department listing dates and hours for each residential and commercial irrigation upon which the billings are based. The average residential irrigation typically takes between 1 to 3 hours per month. Using an average of 2 hours per month per customer equates to about $73.37 per month or about $807.07 per eleven-month season. It addition, using 6 hours per month per commercial customer results in a cost of about $2,546.28 per season.

Due to the relatively small size of the residential irrigation system, Mesa cycles irrigation deliveries every other week, which allows adequate time for maintenance of the system during the off irrigation week. The City of Mesa has found bi-weekly maintenance to be extremely beneficial as their system is over 60 years old. This approach cannot be used in the City of Tempe due to the much larger size of the irrigation service area and the complexity of the system. The City of Mesa irrigation maintenance program does not include insitu-lining or other pipe replacement programs at this time.

3.3.3 City of Glendale

As discussed in section 3.2, the City of Glendale contracts out the operation of its urban (residential) irrigation program to Salt River Irrigation, a private commercial irrigation company. The contract is administered through a city liaison with the Glendale Utilities Department. The liaison person is also responsible for inspection and minor maintenance to the irrigation system. Residential irrigation customers in Glendale can opt out of the program and self-irrigate if they wish; however, once out they cannot opt back in. City of Glendale personnel perform non-residential irrigation of street medians and landscape tracts. The source of raw irrigation water is SRP. Approximate cost to lot owners is $330 to $395 per lot per year.

The City performs enough maintenance and repair of the private residential and commercial irrigation system to keep the system functioning. Major repairs are performed when necessary with costs covered by the City budget.

The City is actively exploring options to stop providing the private irrigation delivery service to urban irrigation properties. The recent Peoria program conversion is being evaluated for its application in Glendale.

3.3.4 Town of Gilbert

The Town of Gilbert (Gilbert) operates a city run residential irrigation system that serves about 125 residential customers and 3 city parks. The service area covers about 5 square miles and delivers water from the SRP primary delivery system to each of the private residential and commercial property owners. The Town has one full time employee that operates the system, spending about 64 hours per month on the irrigation program. The repair and maintenance of the system is the responsibility of the property owners; however, the Town performs most of the maintenance and repairs to the irrigation system using the Gilbert Public Works Construction Department to do major repairs and/or components replacement. Cost to customers is $120 per year and covers the cost of water delivery and approximately 20 irrigations per year.

3.4 Similar Irrigation Program Summary

There are other irrigation delivery programs in the valley and the costs for these programs vary greatly. Cost of raw water delivery from SRP varies from approximately $60 to $125 per year depending on the size of the lot. This cost does not cover the cost of irrigating the property. A private water delivery company charges approximately $270 per year for delivery from the SRP turnout to the property, but does not cover the cost of long-term maintenance and restoration of the irrigation system. Gilbert and Peoria are or were providing services similar to the City of Tempe and charging between $90 and $125 per year for water delivery and distribution from the primary water irrigation district to the individual customer. These cities are/were barely covering the cost of irrigation water delivery and are/were not providing long-term maintenance/rehabilitation without financial input from other revenue sources. Mesa claims to be providing a full-service program and maintaining their system in a program that is fully funded; however, the maintenance described does not include insitu-lining or major pipe replacement that becomes necessary as a system ages. Mesa estimates they are charging approximately $807 per year for residential users and $2,546 per year for larger commercial properties. In summary:

Typical SRP water delivery cost to the self-irrigating properties	+/- $60 to 125/year/lot
Additional typical delivery charges for non-self-irrigating properties:	
Private Water Company Delivery Cost (no short- or long-term maintenance costs)	+/- $270/year/lot
Total Estimated Cost including SRP & Delivery Fees	+/-$330 to 395/year/lot
Other Valley Irrigation Program Costs (all costs include the cost of SRP water delivery)	
Historical Peoria Delivery Cost (maintenance costs heavily subsidized)	$150 to $215/year/lot
Glendale Delivery Cost (maintenance costs heavily subsidized)	$330 to 395/year/lot
Mesa Delivery Cost (no long-term pipeline repair/replacement program)	+/- $807/year/lot
Gilbert Delivery Cost (maintenance costs heavily subsidized)	$120/year/lot

Table 3.1
Summary Of Residential Irrigation Programs For Phoenix Area Cities
City of Tempe Irrigation Program Analysis—2006

City	Irrigation Program	No. of Customers	Cost to customer	Frequency Of Delivery	Total full-time employees	Maintenance Team	Operation Team	Who Irrigates City Facilities?	Any self serve customers?
Peoria 623-773-7204	Historical Program only	50 historically	$90/year/customer; excluding the cost of SRP water delivery (Approx. $60 to $125). Approx. $150 to $215/year/lot			City returned system to private due to upcoming maintenance costs	City historically provided	Not part of the residential program	No – Could only receive water from City
Mesa 480-644-2592 480-644-2135	Yes	218 Resid. 61 Coml.	$34.03+7.8% tax per hour, includes cost of SRP water. Approx. $807/year/lot	21 or 22 runs per year	3.5	City, will use construction dept for major work.	City Irrigation schedule provided Nov/Dec	City staff	No – Can only receive water from City
Glendale 623-930-4756	Yes	400	$15.00 per irrigation run plus cost of SRP water Approx. $330 to 395/year/lot	18 runs per year	1.5	City provides minor maintenance	Contracted to Salt River Irrigation Co.	City staff	No – Can only receive water from City
Gilbert 480-503-6801 480-503-6434	Yes	125	$120/year/customer; includes cost of SRP water Approx. $120/year/lot	20 runs per year	1 (approx 64hrs/mo)	Responsibility of land owner, but City does about 90%	City	City irrigates 3 parks	No – Can only receive water from City. Maybe 2 older accounts that self irrigate
Tempe	Yes	900	Fees include cost of SRP water Approx. $305 to $1014/year/lot	18 runs per year	8 irrigators	City has been maintaining the system.	City	City Staff	Yes, up to 500 lots in the service area.

4.0 PROGRAM ADMINISTRATION OPTIONS

The irrigation system operated by the COT was constructed in a piecemeal fashion many years ago and over many years. It is believed that the system was originally a series of canals and ditches that delivered water to small farmsteads. As the area urbanized, the system was converted to a pipeline system with turnouts to residential and commercial lots.

SRP delivers untreated water to the high side of quarter sections and maintains the irrigation delivery system. SRP does not maintain the distribution system down to the residential and commercial lots. Each parcel has a water right and a water quantity allocated and landowners must pay SRP user fees for the storage and delivery of irrigation water annually. The smallest subdivision SRP recognizes is $1/5^{th}$ of an acre for residential/commercial use.

Inside the COT service area, property owners who receive flood irrigation service from the city pay a user fee. This fee is intended to cover the cost of water service. The City uses the irrigation user fee to pay SRP for water delivery on behalf of the customers and for the maintenance and operation of the main delivery system. The city does not provide any on-site maintenance downstream of the lot turnouts. Self-serve landowners within the city's service area make payment directly to SRP for water delivery and maintain their own water service.

Written rights of access have not been established for most or all of the irrigation distribution system and ownership of the irrigation infrastructure is not clearly established. Landowners have water rights but are required to provide the means for delivery of irrigation water if they want delivery. If the distribution system fails and is not repaired, SRP is under no obligation to deliver water and can stop deliveries to prevent flooding and damage.

Within the COT service area, the City has been maintaining the irrigation distribution system down to the lot turnout as part of its water utilities service. However, the City cannot force landowners to participate in the cost sharing of maintenance and damage restoration even if self-help irrigators within the system cause the property damage. The City has implemented a city code that provides a minimum requirement for on-site property maintenance in exchange for the delivery of irrigation water (TCC 33-77). However, this code is not very detailed and is difficult to enforce under the current authorization process. This code could be strengthened to provide some of the needed improvements to the program.

The City's Water/Wastewater Enterprise Fund contains three programs: water, sewer and flood irrigation. There are approximately 41,000 water and sewer customers and approximately 900 irrigation customers. Each of these programs should be fully funded by its own user fees and the Water Utilities Department has been directed by the City Council to move these three programs to cost recovery. The water and sewer programs user fees have been subsidizing the under-funded irrigation program. Part of this study is to provide options for the City to address this situation.

The following is an analysis of administrative programs that could be implemented for the city's existing service area. Four basic options have been identified:

- Public-Mandated, City-Run Administration
- Irrigation Distribution District Formation
- Self-Serve Program
- Potable Water Conversion

The following discussion is provided for each of these options:

- Formation Procedures
- Impacts to Operation
- Impacts to Maintenance and Capital Improvement Program
- Right of Access Impacts

Chapter 2 identifies the various costs of operation and maintenance and provides a Capital Improvement Program budget that can be used to return the system to full operation and provide annual maintenance to keep the system in good working order. Chapter 5 provides a cost comparison of the four options using the cost information from Chapter 2 and the operational options presented here. The focus of this chapter is on the procedural implementation of an option and the impacts to operation, maintenance and ROW issues.

4.1 Public-Mandated, City-Run Administration

The City could continue to operate the Irrigation Program in a similar manner to the existing program by formalizing the current program. The formalization of the program could address some of the problems with operating and maintaining the system. Specific problems to be addressed include: 1) the imbalance in user fees with actual cost to operate and maintain the system; 2) the difficulty enforcing responsibility by landowners to maintain their on-site systems to prevent flood damage to themselves or other property owners, 3) the written right of access onto the properties to operate and maintain the main delivery system and 4) the necessity to recover costs for irrigation delivery and capital improvements to the system.

4.1.1 Formation Procedures

Several methods are open to the City to formalize the irrigation program including: 1) written Service Agreements, 2) TCC section 33-77 enhancement and/or 3) addition of an easements ordinance for flood irrigation service and main delivery system components. Under any of these implementation options, the City would agree to provide irrigation service, maintain the system and upgrade or repair the infrastructure to continue to provide service. In exchange, the landowners would agree to: 1) pay rates to cover the cost of irrigation service, maintenance

and repair; 2) provide formal access to the irrigation distribution system within their property for service; and 3) maintain their property to standards to reduce or eliminate the potential to cause damage to their property or another property. Failure of a landowner to adhere to the terms of the service agreement or City ordinance could result in the City discontinuing irrigation service to the property.

Allowing options for irrigation recipients to "opt-out" of the program and associated fees raises a number of difficulties for properly maintaining the system and for funding that maintenance. Implementation of a two-part user fee could allow property owners to continue to "opt-out" of the irrigation delivery service and still provide the funding required for the Capital Improvement Program that is required to maintain the irrigation system in perpetuity.

Those customers within the Service Area who wish to permanently "opt-out" of flood irrigation and convert to potable water delivery could be handled in a similar fashion to the procedures used for conversions made when residential lots are rezoned commercial. Water rights from these conversion properties are "cut-over" to the City and the lots then receive their water through the City's potable water supply system. Once a lot is cutover, it remains on the potable system and cannot return to flood irrigation. Customers that convert to potable water would then not be subject to either the water delivery or the capital improvement user fees for flood irrigation.

4.1.2 Impacts to Operations

The service agreement and/or ordinance improvement options would basically continue the existing program, while providing the city more formal authority to administer the program. Under a service agreement approach some property owners would continue to receive City irrigation service and some could decide to "opt out" by not signing service agreements. A two-part user fee implemented through Code revision could provide the ability for the City to include self-irrigators in the cost of the capital improvement program without requiring irrigation delivery by the City. Implementation of written service agreements and strengthened City ordinance would be a benefit to the City in that the bulk of the recipients in the area will probably continue service with the City and the City would have the authority to come onto the properties as needed to provide irrigation service main distribution system maintenance and to enforce proper on-lot maintenance to ensure that irrigation on the property will not cause damage. In addition, the implementation of a more stringent City ordinance could reduce or eliminate the risk to the City from property owners that fail to maintain their portion of the on-site irrigation features.

4.1.3 Impacts to Maintenance

The existing user fee rates have not provided adequate funding for the program and the water and sewer programs have been supporting the irrigation program. In the past some property owners have changed from City service to self-irrigation to avoid the increased user rates that funded both the water delivery and the long-term capital improvement program. These self-irrigators received the benefit of an improved irrigation system without funding the improvements. A two-part user fee could address the problem of acquiring funding for capital improvements to the irrigation system from self-irrigators within the Service Area.

Allowing property owners to convert to potable water to avoid the cost of capital improvements to the flood irrigation system could encourage property owners to convert to potable water. Fewer users on the irrigation system could lead to fewer reaches that will require maintenance and improvement. On the other hand, fewer flood irrigation users could lead to increased per user costs without the ability to abandon given reaches of the system.

The City Council always has the option to fund a portion of the water delivery and/or capital improvement program costs from the General Fund. Capital improvements could also be funded through bonding that is either funded by the General Fund or user fees. A last alternative would be to continue to operate the system until failure without capital improvements. This option runs the risk of damage to streets and adjacent properties. At the time of failure, alternative water delivery would be required; probably through the potable water supply system.

4.1.4 Right of Access Impacts

The City could assert ownership of the flood irrigation system. Although a service agreement would include the requirement for landowners to provide a right of access for the City to provide service and maintain the main distribution system, portions of the system in self-irrigated areas would be outside the City's control because there would still be properties and system components that the City does not have access to where landowners do not enter into service contracts. Improving the existing City ordinance or adding an easement provision for flood irrigation to the City code could address the problem of access to the main distribution system.

4.2 Irrigation Water District Formation

Groups of people living in close proximity to each other, and having common purposes, often form organizations to handle the day-to-day functions of providing water, sewer, fire protection and other common services. State statutes address the formation of a variety of districts for various purposes including irrigation water delivery.

4.2.1 Formation Procedures

State statutes allow for the formation of various special districts by groups of individuals when necessary to provide a common service. In this case, there appear to be three types of districts/ organizations that could be formed to provide for flood irrigation. The first is the Community Facilities District found in Title 48, Chapter 4, Article 6 of the Arizona Revised Statutes (A.R.S. 48-701 et seq.). The second is the Irrigation Water Delivery District found in Title 48, Chapter 20 of the Arizona Revised Statutes (A.R.S. 48-3401 et seq). A third formation procedure that could be used is a non-profit corporation under Title 10 of the Arizona Revised Statutes (A.R.S. 10-3101 et seq.).

The statutes detail the formation process, selection of a Board of Directors, rights and responsibilities of the Districts/Corporations and limitations of the Districts/Corporations. Essentially, the Districts/Corporations are separate entities that are formed to create a method by which citizens can provide themselves a service or have a service provided for them. The formation documentation may include the existing irrigation distribution system as part of the

District/Corporation; however, the Statutes are not clear as to whether this would stand under judicial review because of the ownership question. Typically districts are formed to construct new facilities (see additional discussion in Section 4.2.4) and the question of pre-existing facilities is not covered explicitly.

4.2.2 Impacts to Operation

Operation of the resulting District/Corporation would be the responsibility of the District/Corporation, and the District/Corporation could contract with the City or a private company to provide the operation, or decide to return to self-irrigation, or hire their own staff. Fees would be established by the governing board and would be set based on the actual cost of providing the service. The Board of Directors would be responsible for identifying the operation mechanism. The District/Corporation would decide whether landowners could "opt-out" of the system or not (see additional discussion about existing system ownership in Section 4.2.4).

4.2.3 Impacts to Maintenance

Maintenance of the District/Corporation features would be the responsibility of the Board of Directors to determine. The members of the District/Corporation would be responsible for funding the maintenance of the system.

4.2.4 Right of Access Impacts

It is not clear whether the existing irrigation infrastructure could be made a part of the District/Corporation or could be taken through eminent domain procedures. Ownership of the existing system is not clear. However, one option in a public vote might be to include all the existing features and to describe them as part of the District/Corporation. The resulting District/Corporation could assert ownership of the existing irrigation system components unless challenged in court. If a mechanism cannot be found to include the existing irrigation distribution features as part of the Irrigation Water Delivery District or Community Facilities District or Non-Profit Corporation, then the resulting District/Corporation would still be operating a system that is not owned by the operating organization and would likely need some form of service contract with the landowners.

4.3 Self-Serve Program

SRP provides water to residential and commercial lots in the Salt River Reservoir District through "self-serve" programs. In these programs, property owners request water during the regular delivery schedule from SRP and irrigate their own property or hire private irrigators to provide the service. As discussed in Chapter 3, there are private irrigators that can provide water delivery to residential users. However, landowners will still be required to maintain the irrigation system. Funding for this in other areas is handled through a voluntary self-charging method. This may not be acceptable to the City or to ASU if they wish to continue to use the system for their needs nor is it likely to be acceptable to the City in the event that failure to maintain the system properly causes damage to other City facilities (streets, alleys, water and

sewer lines, etc.). The City could find itself implementing the Capital Improvement Program and then requesting "voluntary" payment from the property owners.

4.3.1 Formation Procedures

The City has been providing irrigation service to a decreasing number of flood-irrigated Tempe properties. Over the last 15 to 20 years some property owners have chosen to self-serve because they were unhappy with rate increases or felt they could save money by irrigating their properties themselves and many others have ceased flood irrigation of their properties. The City could elect to stop providing irrigation service, leaving all the irrigation recipients in "self-serve" status. The only formation procedures that would be required are for the City Council to direct City Staff to stop providing the service and to dismantle the irrigation program in the Water Utilities Department.

4.3.2 Impacts to Operation

In a self-serve program, each landowner is responsible for either notifying SRP of the need for water in the regular irrigation schedule and operating their irrigation delivery themselves, or hiring a private company to provide this service. The City and ASU may continue to operate their flood-irrigated properties but would require significantly fewer employees. In fact the City could opt to contract out these services, similar to the Gilbert program discussed in Chapter 3.

4.3.3 Impacts to Maintenance

As discussed above, in other self-help areas, the property owners have formed loose, volunteer organizations that identify maintenance requirements and then request voluntary funding from the flood irrigation recipients. If insufficient funds are collected to make the necessary repairs, then the system is shut down by SRP to prevent damage to property owners. There is little or no proactive maintenance of the irrigation system and when the system ultimately fails, property owners either fund the repairs or replacements, or convert to potable water for their irrigation needs.

In this case, failure to maintain the system may not be acceptable to the City or ASU if they wish to continue to provide flood irrigation to their properties. The cost of implementing the Capital Improvement Program could be funded by the City and requests to water users to participate could be made as a voluntary basis. The City should anticipate only a limited amount of reimbursement from residents under this type of voluntary payment program.

Another option is to run the system as long as it will last and then shut down various reaches as they fail. Conversion to potable water would be required at that point.

4.3.4 Right of Access Impacts

All the landowners on the delivery line have an interest in the common delivery system, although legal ownership is unclear. Private irrigation water delivery companies receive written right of access to specific properties that they service through the service agreements.

Maintenance or repair of the system is usually completed by a contractor if adequate funds are collected or by one of the landowners. There is no guarantee that any specific landowner will allow access or that repairs will be adequate for long-term operation.

The City and ASU receive water through the common irrigation delivery system. The City may have problems with damage from self-irrigators and in the end remain responsible for repairs to flood-damaged city property.

4.4 Conversion From Irrigation Water to Potable Water

One option to consider is the use of potable water in lieu of untreated SRP irrigation water. It is normally expected that raw water will be less expensive to deliver and use for irrigation than potable water because of the cost of treating and pressurizing the delivery system. However, one of the reasons for lower costs in an irrigation system is that long-term maintenance of the irrigation distribution system rarely occurs downstream of the SRP system. In addition, the distribution of irrigation water is relatively inexpensive for larger farm units because the distribution systems are usually aboveground ditches with flood irrigation of large areas or large pressurized sprinkler systems that cover up to 40 acres at a time. The distribution system for residential areas is significantly smaller, more detailed and therefore more labor intensive and more expensive to operate and maintain. Cost comparisons between the options are addressed in Chapter 5.

4.4.1 Formation Procedures

As a policy decision by the City Council, the City could provide financial incentives to the irrigation recipients or merely point out the cost advantages of converting to potable water in order to encourage residents to convert to potable water. The City cannot force existing property owners to convert from flood irrigation to potable water, but this may occur if the City converts to a fully funded irrigation service and landowners unwilling to self-irrigate are faced with higher user fees.

4.4.2 Impacts to Operation

If smaller residential and commercial landowners decide to convert to potable water, then the operation and maintenance could be reduced to just ASU and city park areas. Even ASU and the City might opt to convert to potable water depending on the cost of water service.

4.4.3 Impacts to Maintenance

Less of the system will require repair and maintenance, but there will also be fewer participants to share the cost amongst. The fewer the users of the irrigation system, the more costly it is to the remaining users to maintain the system.

4.4.4 Right of Access Impacts

If all flood irrigators convert to potable water, then the irrigation system can be abandoned.

4.4.5 Landscape Concerns With Conversion to Potable Water

One concern that property owners have expressed in the past with the conversion to potable water is the loss of lush lawns and large trees. Conversion to potable water does not necessarily cause the existing vegetation to fail if proper irrigation systems are installed and proper watering cycles are followed. Appendix A provides detailed recommendations for an irrigation system that could replace flood irrigation for lawns and large trees.

The most important factor in converting from a flood-irrigated system to a potable water irrigation system is to ensure that adequate water is applied to the grass, shrubs and trees. According to SRP, residential land may receive up to 6 ac-feet per acre of water. It is estimated that turf in Arizona requires approximately 4.8 ac-feet per acre of water per year. A 1/5th lot will require approximately 1 to 1.2 ac-feet of water per year.

4.5 Options Evaluation

Evaluation and comparison of the options is discussed in detail in Chapter 6.

5.0 COST ANALYSIS FOR PROGRAM ALTERNATIVES

An economic analysis was prepared to compare the cost of operating and maintaining the irrigation system under the various administrative alternatives. The following financial elements are addressed for each alternative:

- Salaries and Wages
- Fringe Benefits
- Materials and Supplies
- Fees and Services
- Internal Service
- Recommended Operation and Maintenance Items
- Other Income
- Irrigation Revenues

The four alternatives from Chapter 4 are presented as Cases in Appendix B with detailed financial analysis. Historical information is provided for Case 1 and it is assumed that the conversion for all four cases can occur over a one-year period and be in place by 2007. Additional assumptions for each of the administrative alternatives for each financial element are also provided in Appendix B.

The economic approach taken in this analysis is to attempt to compare the alternatives against each other; apples to apples cost-wise. The focus of the analysis is on the operation and maintenance and the capital costs associated with the various options. The administrative cost of implementing any of the optional programs has not been included. In addition, the impact of ASU receiving water through the same system and the partnering with the City to maintain a portion of the system has not been analyzed in detail. This arrangement has a greater potential impact on the self-serve and conversion to potable water alternatives than on the public-mandated, city-run or irrigation district formation alternatives.

The analysis does not address the potential impact to irrigation employees currently employed in this program and it is not the intent of the report to suggest that these employees will be extraneous in the event the City disbands the irrigation program. Typically, employees are absorbed into other City Departments when a department is disbanded or eliminated.

5.1 Public-Mandated, City-Run Administration

The costs associated with continuing the operation of the irrigation system by the City of Tempe consist primarily of salaries and wages and associated fringe benefits. These two cost items alone make up almost 45% of the costs to be recovered by irrigation revenues. The other major cost component is the proposed system improvements and major maintenance programs discussed earlier. If approved, these costs will comprise almost 43% of the total revenue requirements needed to operate the irrigation system. The cost of water delivery by SRP to the City is a rather minor cost item when compared to the other costs to operate and maintain the irrigation system. Assuming the City wants to at least recover all costs required to operate and maintain the irrigations system an increase in irrigation rates of 85% will be required.

The average annual cost to operate the irrigation system over the period 2007 to 2015 is estimated to be $848,100. The estimated user fee for property owners varies depending on the size of lot. In 2006 the current program annual user fees range from $330 to $1000 for lots less than 13,068 square feet to over 34,849 square feet. In 2007 these annual fees range from $840 to $2390 and by 2015 from $1260 to $2800.

5.2 Irrigation Water District Formation

The costs associated with operating an Irrigation Water District are similar to the Public-Mandated, City-Run alternative. The primary differences are removal of Internal City Service charges, addition of administrative and clerical staff and the inclusion of debt service costs associated with the Capital Improvement and Major Maintenance programs discussed earlier. The additional staff and debt service costs cause this alternative to be the most costly option. The actual cost to form the District has not been included in the financial analysis.

The average annual cost to have an Irrigation District operate and maintain the irrigation system over the period 2007 to 2015 is $883,000. The estimated user fee for property owners varies depending on the size of lot. In 2006 the current program annual user fees range from $330 to $1000 for lots less than 13,068 square feet to over 34,849 square feet. In 2007 these annual user fees range from $860 to $2440 and by 2015 from $1240 to $2800.

5.3 Self-Serve Program

The costs associated with this alternative are significantly reduced for the City because there is less need for the existing irrigation employees within the program. These employees are shifted to other duties and other programs. For the economic analysis, it is assumed that under this alternative the City will need to continue to provide service to their own irrigation areas (parks) and to Public Schools and that ASU will continue to operate their flood irrigation system. The City will not need as many irrigators and could in fact contract with an outside firm to schedule water delivery and regular maintenance. The economic analysis assumes that the full time employees and associated fringe benefits will be removed from the program and that a contracted service will be used for the City. It is also assumed that the recommended Capital Improvements and Major Maintenance programs will still be implemented and these costs will become the major costs items in the program. Rates have been prepared to show the cost

sharing that the self-serve users would be asked to participate in. The cost analysis does not include any political or legal costs that may be associated with this alternative.

The estimated average annual cost to operate and maintain the irrigation system using this alternative is estimated to be $421,000. In 2006 the current program annual user fees range from $330 to $1000 for lots less than 13,068 square feet to over 34,849 square feet. The annual average cost for property owners for the Capital Improvement Program varies in 2007 from $434 to $1230 and by 2015 from $612 to $1360. It is estimated that if property owners use a private water delivery company, the cost will be approximately $270 per year and the cost of SRP water delivery will range from $60 to $125 per year. Total annual cost for property owners in 2007 will range from approximately $764 to $1625 based on lot size.

5.4 Conversion From Irrigation Water to Potable Water

The costs associated with this alternative are minimal for the irrigation program. The costs associated with salaries and wages, equipment, water delivery cost and Capital Improvement and Major Maintenance would no longer be applicable. The major cost item would be those costs associated with the abandonment of some of the system – the part not required to serve ASU and City Parks. How ASU and City parks would be handled has not yet been determined. Using the City of Tempe potable water rates that become effective 1 November 2007 irrigation customers would pay less in potable water rates than they would under any of the other alternatives and comparable to current potable water rates. The primary reason for this is that the costs associated with operating and maintaining, treating and delivering potable water is spread out over all of the City of Tempe water customers providing a much bigger base to recover the costs. It is also assumed that the existing potable water supply system is adequately sized to handle the additional capacity required to irrigate the lots.

The estimated average annual cost to operate and maintain the irrigation system using this alternative is estimated to be $0 because the system is no longer used. The average annual cost to operate the potable water system is already included in the rate analysis that generated potable water rates. The estimated user fee for property owners varies depending on the size of lot; it is anticipated that the larger the lot, the more water required for irrigation. It was also assumed that water usage for irrigation is the same whether the source of water is from the irrigation system or the potable system. In 2006 the current program annual user fees for irrigation water range from $330 to $1000 for lots less than 13,068 square feet to over 34,849 square feet. In 2007, the annual potable water fees range from $320 to $966 and by 2015 from $382 to $1226. It is estimated that the cost to install a potable water irrigation system would run around $5,000 to $7,000 depending on the size and complexity of the irrigation system. This would be a one-time fee with minimal annual repair costs.

5.5 Options Evaluation

It should be noted that on a per resident basis the cost is comparable for Alternatives 1 through 3 and comparable to the Mesa flood irrigation costs presented in Chapter 3. The City of Mesa is the only other flood irrigation system that is currently attempting to maintain the irrigation system for the long-term by implementing a good maintenance program. Conversion to potable

sprinkler/drip irrigation is less expensive than flood irrigation when the system is maintained for the long haul. Additional evaluation and comparison of the options is discussed in detail in Chapter 6.

6.0 ALTERNATIVES EVALUATION

The decision about how to proceed is based on more than just a simple cost analysis; therefore a matrix listing the issues versus the alternatives has been prepared to assist in the evaluation of the various alternatives. This matrix is presented below.

Public-Mandated, City-Run Administration	**Irrigation Water District Formation**	**Self-Serve Program**	**Conversion to Potable Water**
Estimated Annual Average Cost for irrigation program is $ 848,100,000.	Estimated Annual Average Cost for irrigation program is $ 883,000. (Irrigation District will Finance recommended improvements.)	Estimated Annual Average Cost for irrigation program is $ 421,000.	Estimated Annual Average Cost for irrigation program is $ 0. Estimated cost of sprinkler installations is $5,000 to $7,000 per lot.
Estimated Average Annual Revenues from Customers is $766,000. (Assumes full recovery of all costs.)	Estimated Average Annual Revenues from Customers is $825,000. (Assumes full recovery of all costs.)	Estimated Average Annual Revenues from Customers $421,000. (Assumes full recovery of all costs.)	Estimated Average Annual Revenues from Customers $291,000. (Based upon City Rates in effect 11/1/07.)
Estimated Average Annual Cost per Residential Unit (based on lot size): 2006: $330 to $1000 2007: $840 to $2390 2015: $1260 to $2800	Estimated Average Annual Cost per Residential Unit (based on lot size): 2006: $330 to $1100 2007: $860 to $2440 2015: $1240 to $2800	Estimated Average Annual Cost per Residential Unit for CIP Program only (based on lot size): 2006: $330 to $1000 2007: $434 to $1230 2015: $612 to $1360 Including SRP & Delivery: 2007: $764 to $1625 2015: $942 to 1755	Estimated Average Annual Cost per Residential Unit (based on lot size): 2006: $330 to $1000 2007: $320 to $966 2015: $382 to $1226
Service contracts and/or ordinance modifications are recommended to implement program.	Irrigation District, Community Facility District or non-profit corporation formation are best implementation options.	City Council could elect to stop providing service and return system to “sell-serve”.	Conversion could be encouraged through funding assistance from the City.

Public-Mandated, City-Run Administration	**Irrigation Water District Formation**	**Self-Serve Program**	**Conversion to Potable Water**
COT will provide maintenance and delivery of the system.	Both District processes require City involvement to establish original boards.	Property owners can self-irrigate or hire private companies.	City cannot force abandonment of the system.
Agreement/Ordinance will include minimum on-site standards.	Ownership of existing facility is not covered clearly in State statutes.	Property owners will be responsible for daily operation and repairs and long-term maintenance.	There is still a risk that self-irrigators will damage the system and there is limited recourse for the City.
Agreement/Ordinance will provide right of access for maintenance.	District/Corporation could "test" ownership of existing system by including system as part of the formation process.	COT, Schools and ASU are in better position to self-irrigate than property owners.	COT, Schools and ASU will need to determine financial impact of conversion or will have to maintain the system on their own without other landowners.
Program can be subsidized by General Fund to reduce user fee.	District/Corporation may have to use service contracts as well.	There is still a risk that self-irrigators will damage the system and there is limited recourse for the City.	
Not all property owners may enter into an agreement but strengthening City ordinances could address most of the access issues.	District/Corporation will be responsible for operation and maintenance.	Maintenance and repairs to system will be voluntary.	
Anticipated that most property owners will sign agreements if user fees are relatively low.	District/Corporation could contract with COT to operate and maintain.	City may have the same or similar maintenance costs in order to maintain lines for their irrigation.	
City still will not "own" the system, but ordinance modifications could address many of the issues.	District/Corporation will be responsible for setting rates.	City may opt to implement the CIP program and have landowners voluntarily participate.	

Public-Mandated, City-Run Administration	Irrigation Water District Formation	Self-Serve Program	Conversion to Potable Water
There is still a risk that self-irrigators will damage the system and there is limited recourse for the City; however, ordinance modifications could address much of this issue.	Bonding may be difficult because the system has not been economically viable.		
	There is still a risk that self-irrigators will damage the system and there is limited recourse for the City.		
	COT, Schools and ASU may be part of District/Corporation.		

FIGURES

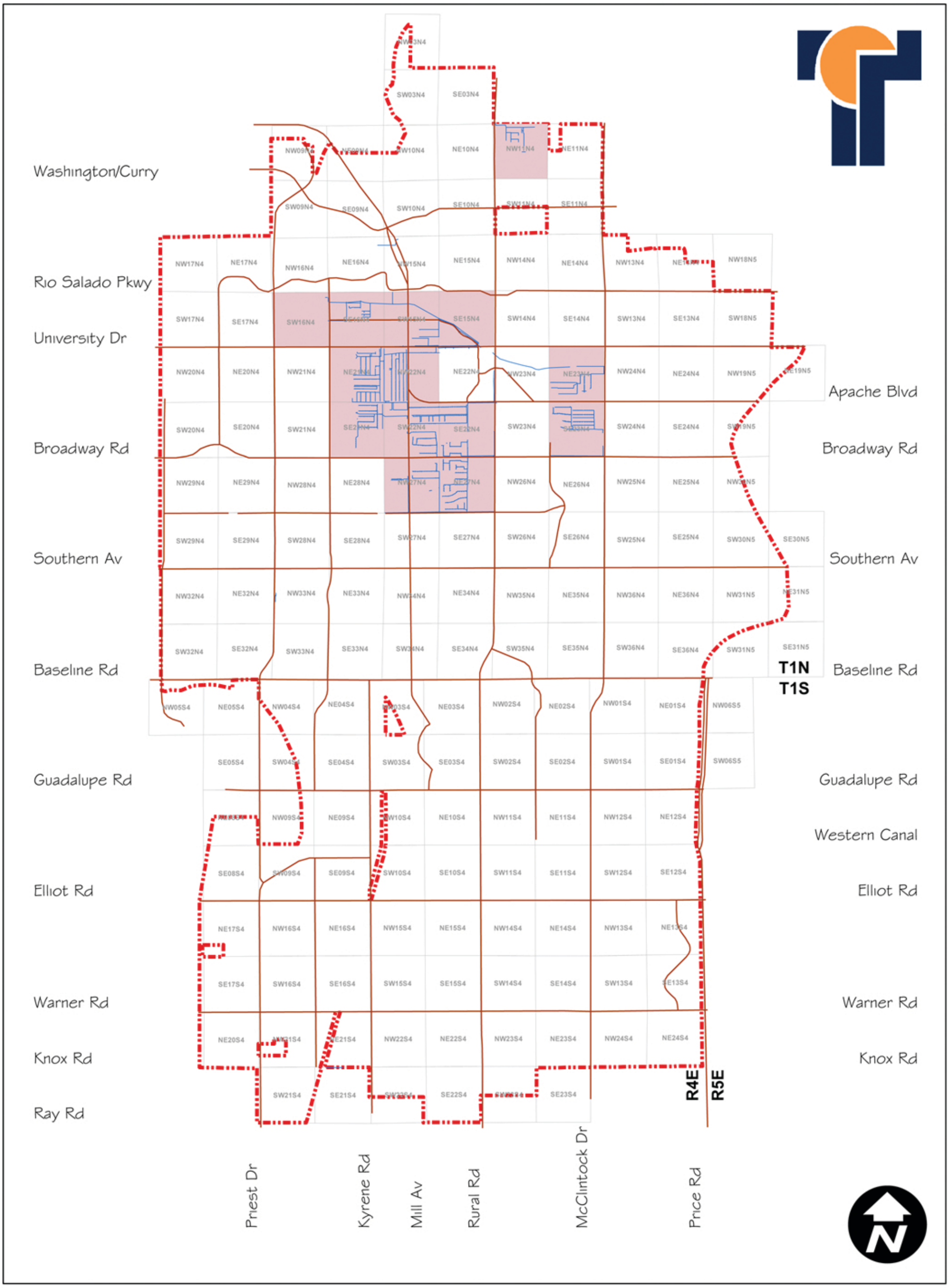


FIGURE 1
IRRIGATION SERVICE AREA
CITY OF TEMPE

Legend

- IRRIGATION LINE
- MAJOR STREET
- CITY LIMIT
- QUARTER SECTION
- IRRIGATION SERVICE AREA

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APPENDIX A
LANDSCAPE CONCERNS WITH CONVERSION TO POTABLE WATER

The following is a set of recommendations for an irrigation system that could replace flood irrigation for lawns and large trees. There are many factors that go into maintaining a healthy landscape that are beyond the scope of this report; therefore, the discussion below only addresses general topics that should be considered when evaluating the conversion from flood irrigation to an underground pressurized irrigation system for lawns and other landscaping. The key to successful conversion is maintaining adequate water supply to the vegetation.

A.1 Turf Irrigation

Existing turf can effectively be converted to utilize potable water by installing an underground, pressurized irrigation system with pop-up sprinkler heads. The sprinkler heads would be selected and sized to accommodate the area being watered, from small-scale residential sites to large-scale sites such as parks and athletic fields. Once a proper system is installed, the quality of the turf can be as good as or better than it was when it was watered with flood irrigation water.

A.1.1 Opportunities

Automation: Underground sprinkler irrigation systems can easily be automated utilizing electric irrigation controllers. They can be as complex or as simple as needed, depending on many factors such water availability, size of the site, and owner requirements.

Irrigation Scheduling: An advantage of an automatic underground piped system is that the watering times and amount of water applied can be totally controlled to match the needs of the turf and of the user. This includes watering at times during the day when evaporation is the least, when it will impact the potential users the least and when the water pressures are at their highest.

Remote Monitoring: For large-scale projects such as City parks, public facilities and streetscapes, the system can also be remotely monitored and controlled. That will allow staff to quickly identify any problems with the system, such as broken lines and missing or damaged sprinkler heads, and promptly address them; potentially saving water and minimizing hazards. The watering schedule can also be remotely controlled to adjust for seasonal water requirements and drought conditions.

Aesthetics: From an aesthetic viewpoint, utilizing an automatic underground sprinkler irrigation system would allow for more flexibility in the design of a project than is possible with flood irrigation. An example would be changes in grade, such as landscape mounds and earth berms.

Reduction of Noxious Weeds: Converting from flood irrigation to sprinkler irrigation could provide a reduction in the import of noxious weed seed that is typically carried in the irrigation

water, thereby allowing the development of higher quality turf with less maintenance and/or herbicide use.

Xeriscape Landscaping: Xeriscape landscaping is not a requirement for conversion from flood irrigation to potable water. However, by converting to sprinkler irrigation there is a lot of opportunity to convert turf and other landscape areas to a lower water use landscape. This could result in a reduction in overall water use and even lower long-term water costs to the property owner.

A.1.2 Constraints

Water Volume and Pressure: The availability of adequate water volumes and pressure may not be adequate for large-scale projects. It may be difficult to schedule the watering cycles within the desirable time frames due to a lack of volume or pressure. Both of these issues can be overcome, but may significantly increase the cost for the system. This is only typically called for on large landscaped areas like parks, school grounds, etc.

Watering Frequency: In all likelihood, the turf will require watering more frequently with the underground, pressurized irrigation system as opposed to flood irrigation. However, this may result in a higher quality turf, especially for some hybrid turf grasses. In addition, the underground system may allow for winter over seeding that is not practical with flood irrigation due to seeding difficulties and the winter shut down that takes place each year.

Installation: Installing the underground system will require moderate to significant damage to the existing turf. Depending upon what time of year the system is installed, the health of the turf may not be adversely affected, but it will be noticeable regardless of when it is done. However, depending on the type of turf and its use, the turf appearance should fully recover within one growing season.

A.2 Tree, Shrub and Ground Cover Irrigation

Converting from flood irrigation to an underground system would potentially have the biggest impact on large mature trees. For the most part, they are adapted to having significant water applied over a large area, something that is seldom done when new trees are planted. For large mature trees, the services of a Certified Arborist could be utilized to provide specific input on the watering requirements and the care required to help insure a healthy tree, prior to converting from flood irrigation to a new irrigation system. Shrubs and ground cover can more easily adapt to a new underground system, or be replaced if necessary.

A.2.1 Opportunities

The same opportunities exist for the trees, shrubs and ground cover that exist for turf, including automation, irrigation scheduling, remote monitoring, and conversion to reclaimed water use.

Zoned Irrigation: One significant opportunity that exists with an automatic underground irrigation system is the ability to 'zone' the irrigation system to suit specific plant water requirements. This includes placing trees, shrubs and ground covers on separate valves and stations within the time clock so that the irrigation frequency and amount of water applied can be controlled. As an example, the trees could be watered less often, but for a longer duration, whereas the shrubs and ground cover could be watered more often, but for a shorter duration.

In addition, plants in harsher environments, such as on the south sides of buildings or near hot paving, can be zoned separately from plants that are on the north side of the building or in microclimates. By implementing this type of irrigation, the needs of all the plants can more effectively be met, and the overall water usage kept at the minimum required for healthy plants.

Various Irrigation Components: There are a large variety of methods to apply water with an underground irrigation system. Those methods include sprinkler heads, bubblers and drip irrigation emitters. The specific requirements of the landscape and owner preference should determine what is used. Bubblers are similar in function to the alfalfa valves that are currently used in the flood irrigation system but on a smaller scale; usually one or two per tree. Bubblers can be employed with basins around the trees to hold and contain water.

A.2.2 Constraints

Large Existing Trees: While this does not have to be a constraint in all cases, it is an issue that needs to be specifically and properly handled. Since these trees are typically accustomed to abundant water, reducing the amount of water they receive all at once could have an adverse affect on their short-term and long-term health. In turf areas, the trees will obtain some water from the new turf irrigation system, but that may not be enough. The addition of subsurface irrigation or other means to supplement the water for the trees may need to be provided. Over several years, depending on the type of tree, it's location and health, it may be possible to wean them off of the supplemental watering, but that should be carefully monitored, and not done during the hottest time of the year.

In non-turf areas, all watering will need to be provided by the underground irrigation system. Again, depending on the tree species and where the tree is located, that may mean significantly more water outlets than would normally be provided for new trees in order for the trees to remain healthy long-term.

In some cases, the existing trees may already be obtaining water from additional sources, and will fairly quickly adapt to removing the flood irrigation. They may also obtain water from adjacent planters and other water sources once the new irrigation system is installed.

Root Damage: One unavoidable factor when converting from flood irrigation to a new underground irrigation system is root damage to the existing plants, especially large trees.

Extreme care needs to be taken to minimize damaging the root systems, and especially the roots of mature trees. This includes cutting the roots and compacting the soil within the drip line of the tree. There are established horticultural practices for working around the roots of plants, especially trees, which should be followed.

APPENDIX B
ECONOMIC ANALYSIS AND ASSUMPTIONS

The following description provides the major assumptions used in each of the 4 cases analyzed for each economic element

Salaries & Wages:

Base Case – Continued the use of 8 irrigation positions throughout the 10-year study period and escalated these by 3.0% each per year

Formation of Irrigation Water District – Kept all 8 irrigation positions and added 2 more, one for clerical and one for administration or a total of 10.

Self-Serve – Eliminated all irrigation positions and assumed the City would contract out maintenance of canals and pipes on an as, if and when needed basis.

Potable Water Service – Assumed there would be no employees, as system would be abandoned.

Fringe Benefits:

Assumptions for this follows salaries and wages.

Materials & Supplies:

Except for the Potable Water service it was assumed that M & S as same as Base Case for all cases.

Fees & Services:

These costs are primarily for billings from SRP for water assessment. City Staff (Eric) indicated that the normal allocation is 3.0 AF/acre, and there are no additional charges if water is supplied from stored water. If SRP allocates the 3.0 AF/acre and some of it comes from pumped water then there is an extra charge. Lately, 2003, 2004 & 2005 SRP has been allocating 2.0AF/acre. Also, any water that does not get delivered to irrigation customers because the lot, or area, has been closed or transferred, the associated water from SRP goes to the City and is used in its potable water system.

Base Case – As shown in the projection of revenues, the assumption is that the City will lose an average of 20 irrigation customers per year. This is what they have averaged over the last 3 years. While there will be less and less water deliveries over time, the cost of the water from SRP will continue to increase. It is assumed that the program will continue to provide only 2.0 AF/acre of water deliveries and the cost is what the City paid for water for 2006 and then escalated at 3.0% over the 10-year period. This item is not a major cost item.

Formation of Irrigation Water District – Same assumptions as base case.

Self-serve – These costs are the same as base case.

Potable Water – These costs are removed, as all water would go to City for potable water system.

Internal Service:

This classification of costs is for charges to irrigation operations from other City departments or functions.

Base Case – The costs associated with other departments, City Manager, City Attorney etc., vehicle maintenance and fuel were all escalated at % per year. Other allocated costs were increase slightly. The credit received from other departments, primarily the parks department, was held constant over 10-year period.

Formation of Irrigation Water District – These costs were eliminated because there would be not cross charges.

Self-serve – These costs could be eliminated as it is assumed that most of the irrigation employees would go to Parks Department, Water or Sewer Department, if at all. There is no need for vehicles and only minor transfers because of using employees to perform some of the major maintenance tasks.

Potable Water – Eliminated these costs.

Recommended Operation and Maintenance Items:

These items are based on information provided in Chapter 2.

Base Case – Used numbers generated in Chapter 2 and only split them between Capital Items and items of major maintenance.

Formation of Irrigation Water District – Assumed the new Irrigation Water District would continue to perform these recommendations.

Self-Serve – It is assumed they would want them performed and would have to borrow the money to pay for the items.

Potable Water – Eliminated these items as a cost.

Other Expenses:

Other expense is made up primarily of interest expense that can be allocated to irrigation program.

Base Case – Held constant over 10-year period.

Formation of Irrigation Water District – Held constant over 10-year period.

Self-serve – Income would be rather minor and held at $500.

Potable Water – No other income

Irrigation Revenues:

It is assumed that the number of irrigation customers will continue to decrease by an average of 20 customers per year over the next 10-year period.

Base Case – It is assumed that in the year 2007 the rates would be increased to equal the costs of providing irrigation service.

Formation of Irrigation Water District – Same assumptions as base case

Self-serve – Same assumptions as base case

Potable Water – We calculated how much revenue the City would receive based upon City of Tempe current water rates. This calculation will not generate sufficient revenue.

CASE 1

CITY OF TEMPE

Estimated Revenue Requirements - Continued Operation By City

DESCRIPTION/CATEGORY	HISTORICAL 2003	2004	2005	PROJECTED 2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OPERATING EXPENSES													
Salaries & Wages	$ 243,715	$ 223,173	$ 228,723	$ 234,400	$ 263,500	$ 271,100	$ 279,000	$ 287,100	$ 295,700	$ 304,600	$ 313,700	$ 323,100	$ 332,800
Fringe Benefits	$ 55,596	$ 71,736	$ 73,847	$ 76,200	$ 118,600	$ 122,000	$ 125,600	$ 129,200	$ 133,100	$ 137,100	$ 141,200	$ 145,400	$ 149,800
Materials & Supplies	$ 12,586	$ 12,703	$ 8,513	$ 9,500	$ 9,600	$ 9,800	$ 10,100	$ 10,400	$ 10,700	$ 11,000	$ 11,400	$ 11,600	$ 12,000
Fees & Services	$ 35,490	$ 55,417	$ 24,939	$ 22,500	$ 23,200	$ 23,900	$ 24,600	$ 25,300	$ 26,100	$ 26,900	$ 27,700	$ 28,500	$ 29,400
Internal Services	$ 1,677	$ 17,785	$ 20,179	$ 21,750	$ 23,550	$ 26,350	$ 28,500	$ 31,550	$ 33,850	$ 37,300	$ 40,950	$ 45,050	$ 49,350
Depreciation (1)	$ 20,981	$ 22,558	$ 24,714	$ 23,960	$ 37,250	$ 53,250	$ 54,250	$ 53,750	$ 55,750	$ 35,900	$ 14,100	$ 13,900	$ 14,200
Subtotal	$ 370,045	$ 403,372	$ 380,915	$ 388,310	$ 475,700	$ 506,400	$ 522,050	$ 537,300	$ 555,200	$ 552,800	$ 549,050	$ 567,550	$ 587,550
Recommended Operation & Maint.	$ -	$ -	$ -	$ -	$ 227,500	$ 227,500	$ 227,500	$ 333,470	$ 227,500	$ 227,500	$ 227,500	$ 227,500	$ 333,470
Total Operating Expenses	$ 370,045	$ 403,372	$ 380,915	$ 388,310	$ 703,200	$ 733,900	$ 749,550	$ 870,770	$ 782,700	$ 780,300	$ 776,550	$ 795,050	$ 921,020
Other Expense - Net	$ 7,458	$ 9,975	$ 4,974	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500
Net Operating Expenses	$ 377,503	$ 413,347	$ 385,889	$ 395,810	$ 710,700	$ 741,400	$ 757,050	$ 878,270	$ 790,200	$ 787,800	$ 784,050	$ 802,550	$ 928,520
CAPITAL IMPROVEMENTS	$ -	$ -	$ -	$ -	$ 75,000	$ 75,000	$ 115,000	$ 75,000	$ -	$ -	$ -	$ 40,000	$ -
Total Revenue Requirements	$ 377,503	$ 413,347	$ 385,889	$ 395,810	$ 785,700	$ 816,400	$ 872,050	$ 953,270	$ 790,200	$ 787,800	$ 784,050	$ 842,550	$ 928,520
Increase Over Prior Year				$ 9,921	$ 389,890	$ 30,700	$ 55,650	$ 81,220	$ (163,070)	$ (2,400)	$ (3,750)	$ 58,500	$ 85,970
Percent Increase				2.57%	98.50%	3.91%	6.82%	9.31%	-17.11%	-0.30%	-0.48%	7.46%	10.20%
Average Compound Increase 2007 - 2015													1.80%
PARCEL AREA - SEMI-ANNUAL FEE													
Up to 13,068				$ 164.98	$ 418.59	$ 477.50	$ 536.89	$ 456.74	$ 472.02	$ 485.29	$ 498.56	$ 553.62	$ 631.15
13,069 to 17,424				$ 219.68	$ 536.57	$ 604.43	$ 670.73	$ 562.83	$ 573.37	$ 580.70	$ 587.26	$ 641.42	$ 718.65
17,424 to 21,780				$ 274.40	$ 660.51	$ 733.10	$ 801.38	$ 662.28	$ 664.29	$ 662.28	$ 659.12	$ 708.30	$ 780.57
21,781 to 26,136				$ 329.11	$ 792.20	$ 879.27	$ 961.16	$ 794.32	$ 796.74	$ 794.32	$ 790.54	$ 849.52	$ 936.20
26,137 to 30,492				$ 383.16	$ 922.31	$ 1,023.67	$ 1,119.01	$ 924.77	$ 927.59	$ 924.77	$ 920.37	$ 989.04	$ 1,089.96
30,493 to 34,848				$ 438.54	$ 1,055.61	$ 1,171.62	$ 1,280.75	$ 1,058.43	$ 1,061.66	$ 1,058.43	$ 1,053.39	$ 1,131.99	$ 1,247.49
Over 34,849				$ 493.36	$ 1,187.56	$ 1,318.08	$ 1,440.84	$ 1,190.74	$ 1,194.37	$ 1,190.74	$ 1,185.07	$ 1,273.49	$ 1,403.43

1). Includes depreciation on CCTV camera and associated equipment, beginning in FY 2007.

CASE 2

CITY OF TEMPE

Estimated Revenue Requirements - Formation of Irrigation Water District

DESCRIPTION/CATEGORY	HISTORICAL			PROJECTED									
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OPERATING EXPENSES													
Salaries & Wages	$ -	$ -	$ -	$ -	$ 313,500	$ 322,900	$ 332,600	$ 342,600	$ 352,900	$ 363,500	$ 374,400	$ 385,600	$ 397,200
Fringe Benefits	$ -	$ -	$ -	$ -	$ 101,900	$ 104,900	$ 108,100	$ 111,300	$ 114,700	$ 118,100	$ 121,700	$ 125,300	$ 129,100
Materials & Supplies	$ -	$ -	$ -	$ -	$ 9,600	$ 9,800	$ 10,100	$ 10,400	$ 10,700	$ 11,000	$ 11,400	$ 11,600	$ 12,000
Fees & Services	$ -	$ -	$ -	$ -	$ 23,200	$ 23,900	$ 24,600	$ 25,300	$ 26,100	$ 26,900	$ 27,700	$ 28,500	$ 29,400
Internal Services	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Depreciation (1)	$ -	$ -	$ -	$ -	$ 56,500	$ 53,250	$ 54,250	$ 53,750	$ 55,750	$ 35,900	$ 14,100	$ 13,900	$ 14,200
Subtotal	$ -	$ -	$ -	$ -	$ 504,700	$ 514,750	$ 529,650	$ 543,350	$ 560,150	$ 555,400	$ 549,300	$ 564,900	$ 581,900
Recommended Operation & Maint.	$ -	$ -	$ -	$ -	$ 227,500	$ 227,500	$ 227,500	$ 333,470	$ 227,500	$ 227,500	$ 227,500	$ 227,500	$ 333,470
Total Operating Expenses	$ -	$ -	$ -	$ -	$ 732,200	$ 742,250	$ 757,150	$ 876,820	$ 787,650	$ 782,900	$ 776,800	$ 792,400	$ 915,370
Other Expense - Net	$ -	$ -	$ -	$ -	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500
Net Operating Expenses	$ -	$ -	$ -	$ -	$ 734,700	$ 744,750	$ 759,650	$ 879,320	$ 790,150	$ 785,400	$ 779,300	$ 794,900	$ 917,870
CAPITAL IMPROVEMENTS	$ -	$ -	$ -	$ -	$ 75,000	$ 75,000	$ 115,000	$ 75,000	$ -	$ -	$ -	$ 40,000	$ -
Total Revenue Requirements	$ -	$ -	$ -	$ -	$ 809,700	$ 819,750	$ 874,650	$ 954,320	$ 790,150	$ 785,400	$ 779,300	$ 834,900	$ 917,870
Increase Over Prior Year				$ -	$ 809,700	$ 10,050	$ 54,900	$ 79,670	$ (164,170)	$ (4,750)	$ (6,100)	$ 55,600	$ 82,970
Percent Increase						1.24%	6.70%	9.11%	-17.20%	-0.60%	-0.78%	7.13%	9.94%
Average Compound Increase 2007 - 2015													1.80%
PARCEL AREA - SEMI-ANNUAL FEE													
Up to 13,068				$ 164.98	$ 431.38	$ 478.93	$ 537.48	$ 455.35	$ 471.99	$ 483.81	$ 495.54	$ 548.59	$ 623.91
13,069 to 17,424				$ 219.68	$ 552.96	$ 606.23	$ 671.47	$ 561.12	$ 573.33	$ 578.93	$ 583.70	$ 635.60	$ 710.41
17,424 to 21,780				$ 274.40	$ 680.69	$ 735.29	$ 802.26	$ 660.26	$ 664.25	$ 660.26	$ 655.13	$ 701.87	$ 771.62
21,781 to 26,136				$ 329.11	$ 816.40	$ 881.89	$ 962.22	$ 791.90	$ 796.69	$ 791.90	$ 785.75	$ 841.81	$ 925.47
26,137 to 30,492				$ 383.16	$ 950.48	$ 1,026.72	$ 1,120.24	$ 921.95	$ 927.53	$ 921.95	$ 914.79	$ 980.06	$ 1,077.46
30,493 to 34,848				$ 438.54	$ 1,087.86	$ 1,175.12	$ 1,282.16	$ 1,055.21	$ 1,061.59	$ 1,055.21	$ 1,047.01	$ 1,121.71	$ 1,233.18
Over 34,849				$ 493.36	$ 1,223.84	$ 1,322.01	$ 1,442.43	$ 1,187.11	$ 1,194.29	$ 1,187.11	$ 1,177.89	$ 1,261.93	$ 1,387.34

1). Includes depreciation on CCTV camera and associated equipment, beginning in FY 2007.

CASE 3

CITY OF TEMPE

Estimated Revenue Requirements - Self-Serve Program

DESCRIPTION/CATEGORY	HISTORICAL			PROJECTED									
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OPERATING EXPENSES													
Salaries & Wages	$ -	$ -	$ -	$ -	$ 50,000	$ 51,300	$ 52,600	$ 53,900	$ 55,200	$ 56,600	$ 58,000	$ 59,500	$ 61,000
Fringe Benefits	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Materials & Supplies	$ -	$ -	$ -	$ -	$ 9,600	$ 9,800	$ 10,100	$ 10,400	$ 10,700	$ 11,000	$ 11,400	$ 11,600	$ 12,000
Fees & Services	$ -	$ -	$ -	$ -	$ 23,200	$ 23,900	$ 24,600	$ 25,300	$ 26,100	$ 26,900	$ 27,700	$ 28,500	$ 29,400
Internal Services	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Depreciation (1)	$ -	$ -	$ -	$ -	$ 20,750	$ 53,250	$ 54,250	$ 53,750	$ 55,750	$ 35,900	$ 14,100	$ 13,900	$ 14,200
Subtotal	$ -	$ -	$ -	$ -	$ 103,550	$ 138,250	$ 141,550	$ 143,350	$ 147,750	$ 130,400	$ 111,200	$ 113,500	$ 116,600
Recommended Operation & Maint.	$ -	$ -	$ -	$ -	$ 227,500	$ 227,500	$ 227,500	$ 333,470	$ 227,500	$ 227,500	$ 227,500	$ 227,500	$ 333,470
Total Operating Expenses	$ -	$ -	$ -	$ -	$ 331,050	$ 365,750	$ 369,050	$ 476,820	$ 375,250	$ 357,900	$ 338,700	$ 341,000	$ 450,070
Other Expense - Net	$ -	$ -	$ -	$ -	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
Net Operating Expenses	$ -	$ -	$ -	$ -	$ 331,550	$ 366,250	$ 369,550	$ 477,320	$ 375,750	$ 358,400	$ 339,200	$ 341,500	$ 450,570
CAPITAL IMPROVEMENTS	$ -	$ -	$ -	$ -	$ 75,000	$ 75,000	$ 115,000	$ 75,000	$ -	$ -	$ -	$ 40,000	$ -
Total Revenue Requirements	$ -	$ -	$ -	$ -	$ 406,550	$ 441,250	$ 484,550	$ 552,320	$ 375,750	$ 358,400	$ 339,200	$ 381,500	$ 450,570
Increase Over Prior Year				$ -	$ 406,550	$ 34,700	$ 43,300	$ 67,770	$ (176,570)	$ (17,350)	$ (19,200)	$ 42,300	$ 69,070
Percent Increase						8.54%	9.81%	13.99%	-31.97%	-4.62%	-5.36%	12.47%	18.10%
Average Compound Increase 2007 - 2015													1.80%
PARCEL AREA - SEMI-ANNUAL FEE													
Up to 13,068				$ 164.98	$ 216.60	$ 265.32	$ 311.07	$ 207.79	$ 224.45	$ 220.78	$ 215.69	$ 250.67	$ 306.27
13,069 to 17,424				$ 219.68	$ 277.64	$ 335.85	$ 388.62	$ 256.05	$ 272.64	$ 264.18	$ 254.06	$ 290.43	$ 348.73
17,424 to 21,780				$ 274.40	$ 341.77	$ 407.34	$ 464.32	$ 301.29	$ 315.88	$ 301.29	$ 285.15	$ 320.71	$ 378.78
21,781 to 26,136				$ 329.11	$ 409.91	$ 488.56	$ 556.89	$ 361.37	$ 378.86	$ 361.37	$ 342.01	$ 384.66	$ 454.30
26,137 to 30,492				$ 383.16	$ 477.23	$ 568.80	$ 648.35	$ 420.71	$ 441.08	$ 420.71	$ 398.17	$ 447.83	$ 528.91
30,493 to 34,848				$ 438.54	$ 546.21	$ 651.01	$ 742.06	$ 481.52	$ 504.83	$ 481.52	$ 455.72	$ 512.56	$ 605.35
Over 34,849				$ 493.36	$ 614.49	$ 732.38	$ 834.82	$ 541.71	$ 567.94	$ 541.71	$ 512.69	$ 576.63	$ 681.02

1). Includes depreciation on CCTV camera and associated equipment, beginning in FY 2007.

CASE 4

CITY OF TEMPE

Estimated Revenue Requirements and Revenue - Potable Water Service

DESCRIPTION/CATEGORY	HISTORICAL 2003	HISTORICAL 2004	HISTORICAL 2005	PROJECTED 2006	PROJECTED 2007	PROJECTED 2008	PROJECTED 2009	PROJECTED 2010	PROJECTED 2011	PROJECTED 2012	PROJECTED 2013	PROJECTED 2014	PROJECTED 2015
OPERATING EXPENSES													
Salaries & Wages	$ 370,045	$ 403,372	$ 380,915	$ 234,400	$ 240,300	$ 246,300	$ 252,500	$ 258,800	$ 265,300	$ 271,900	$ 278,700	$ 285,700	$ 292,800
Fringe Benefits	$ 55,596	$ 71,736	$ 73,847	$ 76,200	$ 78,100	$ 80,000	$ 82,100	$ 84,100	$ 86,200	$ 88,400	$ 90,600	$ 92,900	$ 95,200
Materials & Supplies	$ 12,586	$ 12,703	$ 8,513	$ 9,500	$ 9,600	$ 9,800	$ 10,100	$ 10,400	$ 10,700	$ 11,000	$ 11,400	$ 11,600	$ 12,000
Fees & Services	$ 35,490	$ 55,417	$ 24,939	$ 22,500	$ 23,200	$ 23,900	$ 24,600	$ 25,300	$ 26,100	$ 26,900	$ 27,700	$ 28,500	$ 29,400
Internal Services	$ 1,677	$ 17,785	$ 20,179	$ 21,750	$ 23,550	$ 26,350	$ 28,500	$ 31,550	$ 33,850	$ 37,300	$ 40,950	$ 45,050	$ 49,350
Depreciation (1)	$ 20,981	$ 22,558	$ 24,714	$ 23,960	$ 37,250	$ 53,250	$ 54,250	$ 53,750	$ 55,750	$ 35,900	$ 14,100	$ 13,900	$ 14,200
Subtotal	$ 496,375	$ 583,571	$ 533,107	$ 388,310	$ 412,000	$ 439,600	$ 452,050	$ 463,900	$ 477,900	$ 471,400	$ 463,450	$ 477,650	$ 492,950
Recommended Operation & Ma	$ -	$ -	$ -	$ -	$ 227,500	$ 227,500	$ 227,500	$ 333,470	$ 227,500	$ 227,500	$ 227,500	$ 227,500	$ 333,470
Total Operating Expenses	$ 496,375	$ 583,571	$ 533,107	$ 388,310	$ 639,500	$ 667,100	$ 679,550	$ 797,370	$ 705,400	$ 698,900	$ 690,950	$ 705,150	$ 826,420
Other Expense - Net	$ 7,458	$ 9,975	$ 4,974	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500	$ 7,500
Net Operating Expenses	$ 503,833	$ 593,546	$ 538,081	$ 395,810	$ 647,000	$ 674,600	$ 687,050	$ 804,870	$ 712,900	$ 706,400	$ 698,450	$ 712,650	$ 833,920
CAPITAL IMPROVEMENTS	$ -	$ -	$ -	$ -	$ 75,000	$ 75,000	$ 115,000	$ 75,000	$ -	$ -	$ -	$ 40,000	$ -
Total Revenue Requirements	$ 503,833	$ 593,546	$ 538,081	$ 395,810	$ 722,000	$ 749,600	$ 802,050	$ 879,870	$ 712,900	$ 706,400	$ 698,450	$ 752,650	$ 833,920
Revenues from Potable Water Sales					$ 284,800	$ 286,700	$ 288,500	$ 290,100	$ 291,600	$ 293,000	$ 294,000	$ 295,000	$ 295,700
Revenue Deficiency					$ (437,200)	$ (462,900)	$ (513,550)	$ (589,770)	$ (421,300)	$ (413,400)	$ (404,450)	$ (457,650)	$ (538,220)
PARCEL AREA - SEMI-ANNUAL FEE				1).									
Up to 13,068				$ 164.98	$ 150.60	$ 155.12	$ 159.77	$ 164.56	$ 169.50	$ 174.59	$ 179.82	$ 185.22	$ 190.78
13,069 to 17,424				$ 219.68	$ 198.21	$ 204.16	$ 210.28	$ 216.59	$ 223.09	$ 229.78	$ 236.67	$ 243.77	$ 251.09
17,424 to 21,780				$ 274.40	$ 245.82	$ 253.19	$ 260.79	$ 268.61	$ 276.67	$ 284.97	$ 293.52	$ 302.33	$ 311.40
21,781 to 26,136				$ 329.11	$ 293.43	$ 302.23	$ 311.30	$ 320.64	$ 330.26	$ 340.17	$ 350.37	$ 360.88	$ 371.71
26,137 to 30,492				$ 383.16	$ 341.04	$ 351.27	$ 361.81	$ 372.66	$ 383.84	$ 395.36	$ 407.22	$ 419.44	$ 432.02
30,493 to 34,848				$ 438.54	$ 388.65	$ 400.31	$ 412.32	$ 424.69	$ 437.43	$ 450.55	$ 464.07	$ 477.99	$ 492.33
Over 34,849				$ 493.36	$ 483.87	$ 498.39	$ 513.34	$ 528.74	$ 544.60	$ 560.94	$ 577.77	$ 595.10	$ 612.95

1). Based on 2006 flood irrigation water rates and not potable water rates.